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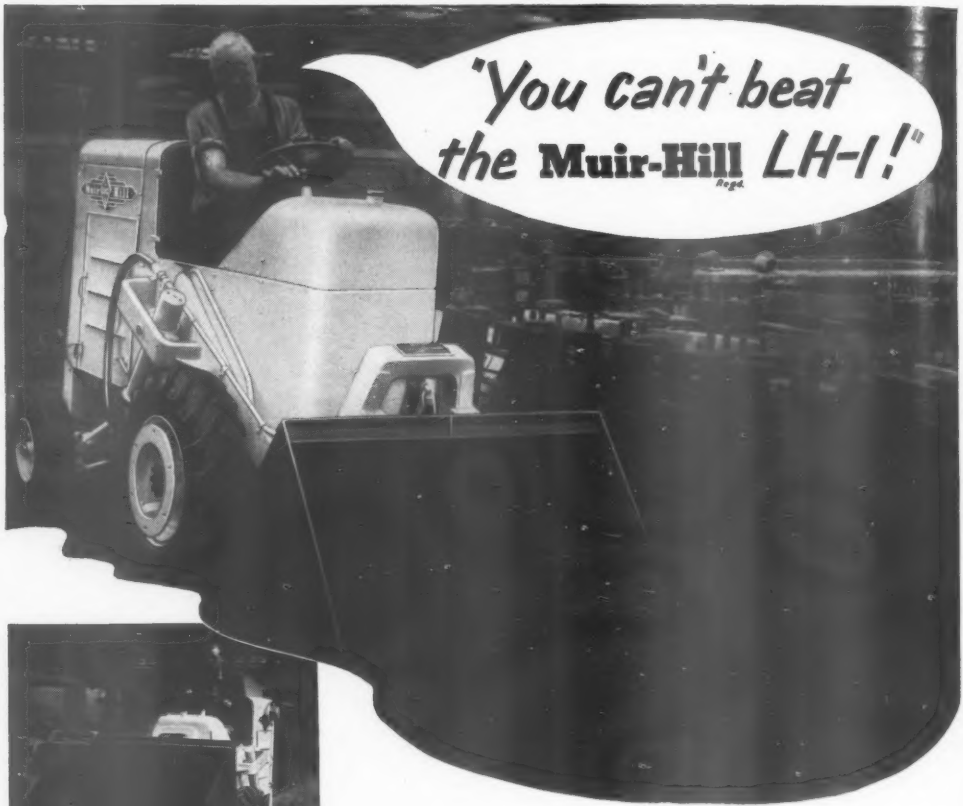

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BSI Annual Report*

In the 1955-56 Annual Report of the British Standards Institution, there appears a very interesting misprint. In covering an international committee meeting held in London dealing with the testing of cast iron, the phrase appears "following the recommendations of the International Association of Foundry Technical Associations." This, of course, should read "International Committee." Now this organization had been effectively functioning since 1926 and we believe the time is ripe for a change of title, for the significance of the word "committee" is no longer adequate to cover its wide activities. A title such as the International Foundry Association, . . . Society, . . . Institute or . . . Institution, but not committee, would be appropriate.

Another feature of the Report which to our mind is very important is the section covering the certification scheme. The value of trade marks is generally recognized and everybody engaged on the manufacture of such proprietary articles or material are always likely to take greater care with their production than with non-trade-marked items. It is interesting to note that it is no longer only consumer goods which are carrying the BS kite certification mark, but industrial components, such as spun-iron pipes, gate valves, manhole covers and flanged iron pipes, are also covered. Whilst this step meets with our full approbation, we still regard a trade mark as a desirable attribute in sales promotion. Many products of the foundry industry are sold as conforming to efficiency standards, which places them in a general class, but each individual firm or even sections of large groups do their best to enhance the reputation of their own apparatus or plant and giving this real identity by the use of trade names.

The Institution has made commendable progress during the year ; membership, revenue and sales of standards all show increases. More attention is being given to overseas trade expansion through the popularizing of British Standards by means of translations and the assembly in booklet form of the more promising types. International activities go on apace, but in these early days, it is difficult to assess their worth. Other bodies deal with such matters as the shipping regulations. The standardization activities, with which we are most familiar, cannot but result in the better appreciation and application of technical work carried out abroad. Naturally, everybody regards the work of the BSI from the angle of the industry with which he is associated, but a perusal of this Report shows up in relief the immense variety of work undertaken for an extremely diverse range of manufacturing activities. Hence, its interest to general readers is markedly widened.

* Price 5s. net from the Institution at 2, Park Street, London, W1.

Restrictive Practices Order

The President of the Board of Trade has announced that the first Order (Registration of Restrictive Trading Agreements Order, 1956) requiring registration of restrictive trading agreements has been made under the Restrictive Trade Practices Act, 1956, which received Royal Assent recently. Copies may be obtained from the Stationery Office, or through any bookseller (price 3d.).

If the Order receives the approval of Parliament it will come into force on November 30, 1956. During the three months following that date, particulars of the classes of agreement specified in the Order must be furnished to the Registrar of Restrictive Trading Agreements. The specified classes of agreements are, broadly, those which include restrictions as to prices or other terms or conditions or which involve collective discrimination. They include agreements about common prices and conditions of sale and agreements about level or agreed tendering. Agreements which contain restrictions affecting exports, and which do not affect supply to the home market, do not have to be registered, but must, under Section 31 of the Act, be notified to the Board of Trade.

Under the provisions of the Act some restrictive trading agreements, *e.g.*, sole agency, patent and trade mark agreements, are in certain specified circumstances exempted from registration.

The office of the Registrar of Restrictive Trading Agreements at Chancery House, Chancery Lane, London, W.C.2 ('phone CHANCERY 2858), was opened on August 7. (The office is not part of the Board of Trade.) Details of the way in which registration is to be carried out will be given in regulations to be made by the Registrar, and these will be issued before the registration order comes into operation on November 30. The regulations will also lay down the fees to be paid for inspecting the register and for copies of, or extracts from, registered documents.

Courses in Vitreous Enamelling

For the session 1956-57, courses in vitreous enamelling will be held at the College of Ceramics, North Staffordshire Technical College, Stoke-on-Trent, beginning on Monday, September 17 (interviewing week: September 10 to 14 inclusive), as follow:—

Full-time Course leading to the Manager's Diploma.

This is a full-time course of three years' duration on the "sandwich" scheme, involving six months' full-time study at the College and six months in a works in each year. The course includes vitreous enamelling, metallurgy, engineering, chemistry and management subjects.

Part-time Course.

This a less comprehensive course of three years' duration in vitreous enamelling and metallurgy, intended for those who can only be released from work on two half days each week.

Full-time Course for Diploma in Ceramics.

This is a three year full-time course intended for scientific personnel. The subjects are chemistry, physics, and ceramics (including vitreous enamelling).

Specialist Lectures on the Production of Vitreous-enamelled Ware.

A series of twelve weekly lectures on the production aspects of vitreous enamelling of sheet steel and castings will be given on Tuesday evenings from 5.15 to 6.30 p.m. commencing on September 25. These will be given by well known technologists from the industry. Further details of the courses can be obtained from the principal of the College, Dr. H. W. Webb, O.B.E., F.R.I.C., M.I.CHEM.E., F.I.CERAM.

Midlands Industry

The Midlands are feeling the combined effects of the credit squeeze and keener competition in world markets more sharply than any other area in the country, it is suggested in the most recent manpower figures, published by the Ministry of Labour on August 9. In the month ended July 16, the number of registered unemployed persons rose by 15,560 to 238,137. This is 53,000 more than a year ago, when trade in the Midlands was booming. In the Midland region alone the unemployment figures rose by 14,893 to 40,548, yet a year ago the region had the lowest percentage rate of unemployment in the country. At 0.4 per cent. it was only half the national figure. Last month, at 2.2 per cent., the rate for men in the Midlands was double the national figure and was the highest of any region in England, Scotland and Wales.

Of the 3,348 workers dismissed from British Motor Corporation factories in the Midlands, who registered at unemployment exchanges, 2,157 have found new jobs, it was stated on August 9 by an official of the Ministry of Labour in Birmingham. The exchanges had 1,191 workers on their books on July 30, the last date a complete check was made. Nearly 1,500 of the dismissed men never registered at an employment exchange it was stated, and Ministry officials are confident that the majority of that number have found jobs for themselves. It is computed, therefore, that fewer than a quarter of the 4,800 workers dismissed in the Midlands by BMC are still registered as unemployed.

Competition for Management Trainees

The chairman of the 25-year-old Institution of Works Managers, Mr. D. G. Petrie, M.I.MECH.E., recently announced a comprehensive list of awards open for competition amongst members of its graduate training scheme in management. Because opportunities for formal education in management are limited, the IWM has taken the initiative in drawing up, in conjunction with technical colleges all over the country, a syllabus of training which includes theory and practice, and employs the resources of the Institution as a sponsoring agent through discussion groups, factory visits and the practical interchange of viewpoints *via* regular meeting by IWM branches. An annual award of the Sir Henry Fildes Medal to the best student carries with it a prize to the value of £20 and prizes of £10 and £5 are awarded to runners-up. In addition, branches responsible for the supervision of the graduate training scheme are empowered to make grants of further prizes to the best students in their own locality.

Corrosion Protection

A 16 mm. sound and colour picture, "Zinc Controls Corrosion," has been produced by the American Zinc Institute, Inc., to show how this metal is used to protect steel against corrosion. The film demonstrates the general mechanism of corrosion and shows how zinc controls the corrosion of iron and steel by acting as a barrier and by giving galvanic protection. It reviews the methods of coating steel with zinc, and surveys the various applications of the coated parts. Continuous galvanizing lines, the hot-dip galvanizing of large structural parts, and such means of corrosion prevention with zinc as cathodic protection, spraying, Sherardizing, and painting are also described. The film is available from the Zinc Development Association, 34, Berkeley Square, London, W.1.

Development and Application of a Foundry Test for Assessing Shrinkage Behaviour in Grey Cast-iron

*By J. Grice, A.M.I.B.F., and J. T. Berry, B.Sc., Ph.D., A.M.I.B.F., A.I.M.**

In a literature survey, the relevant mould and metal variables involved in shrinkage have been reviewed, special attention being drawn to certain theoretical considerations, mainly the rule of Chvorinov and the findings of Pellini and his co-workers. Preliminary work was concerned with the effect of change of feeder-volume : surface-area ratio and depth of unsoundness in a 6-in. side cube in a medium-phosphorus grey-iron. Although this series of graphs did contribute valuable information on the simple system concerned, it displayed several disadvantages, the most important of which was that the difference between "centreline" and under-feeder shrinkage was not developed. A more-suitable test was formulated and several experiments carried out whereby records of temperature gradients during solidification and corresponding shrinkage defects were made available. It was concluded that for the particular alloy used :—(a) *Chvorinov's rule is only partially successful, under-feeder shrinkage persisting;* (b) *that the criterion of Pellini regarding temperature plateaux is not entirely applicable; and* (c) *that although feeding in the latter stages of solidification appears to take place, the persistent under-feeder shrinkage probably depends much on the absence of "mass-feeding."*

Introduction

The advancement of scientific investigation into the feeding of castings is now so rapid that it would appear that some pre-determined formula might be applied, whereby the feeder-size could be calculated to allow the successful manufacture of castings. Foundrymen will agree that many of the great variety of defects found in castings are due to carelessness, but, defects due to shrinkage are generally traced to lack of knowledge of what is happening inside a casting as it cools from the liquid to the solid state. Many complex factors are involved, not the least of which is the mould. Gittus[1] shows that mould conditions have great influences on grey-iron-casting soundness. Dry-sand moulds, with their greater rigidity, unlike green-sand, restrict casting expansion allowing the solidifying eutectic to expand into, and fill, the initially-formed shrinkage cavity.

In the study of making sound castings of considerable weight, in a few types of castings it is found that little, if any, feeding need be provided. An outstanding example is a lathe bed of several tons weight. Here, there is a dry-sand mould with heavy, dry-sand coring, giving extensive areas of thin-section metal. When encompassed by liquid metal, the large areas of mould and core absorb heat rapidly resulting in expansions on to the metal which counteract the initial liquid-shrinkage in the way outlined by Gittus.[1]

The mould also exerts an important influence through thermal properties involved in heat extraction and which depend upon time after casting,[2] material[2,3,4,5] and ramming density,[3,4,5] since these properties will exert a strong influence on temperature gradients within the metal. Metal conditions and composition also have vast effects on casting soundness. Timmins[6] gives a fairly-comprehensive review of the formation of shrinkage defects in cast iron with special reference to the composition of the metal.

However, although shrinkage itself is due to volume changes on cooling, the type of defect is of itself governed by the presence (or otherwise) of a freezing range during solidification and the proportion of solid metal formed during the early part of solidification, together with certain variables involving temperature gradients and ferrostatic pressure. Timmins[6] also indicates the influence carbon, silicon and phosphorus have on the shrinkage of cast iron and also the effect

* Paper presented at the annual conference of the Institute of British Foundrymen in Cardiff, last June.

DR. J. T. BERRY, since 1954, has been metallurgist at the Naval Construction Research Establishment, Forsyth. Educated at Gateway School and the College of Technology, Leicester, he joined the National Gas Turbine Establishment, Ministry of Supply, in 1947, and two years later won a metallurgy scholarship to Birmingham University. In 1952, he was awarded an honours degree in industrial metallurgy and later received his PH.D. for a thesis on the prediction of solidification time, which involved work for sub-committee T.S.46 of the Institute of British Foundrymen.

MR. JOHN GRICE joined Tangyes, Limited, as methods engineer in 1949, and in 1954 was appointed joint foundry manager, being promoted to sole charge this year. This foundry produces castings in grey iron for large hydraulic presses, machine tools, Diesel engines, etc. Mr. Grice also supervises the firm's non-ferrous foundry. He was educated at West Bromwich Grammar School and Wednesbury Technical College, and commenced his career with F. H. Lloyd & Company, Limited, subsequently becoming manager of this company's standards department, where he was connected with costing.

temperature gradients have on shrinkage defects in the same metal.

Other Factors

Two further factors which are involved in several casting and moulding variables are metallostatic pressure and temperature gradients within the casting. Although the first factor has generally been standardized in experimental work, the second has not been, mainly since it is extremely sensitive to many physical features. It has been maintained for some time that the presence of steep temperature-gradients along the longest axis of a casting coupled with that of flat gradients associated with the minor axes promotes "directional solidification[7]." Experimental work has generally confirmed

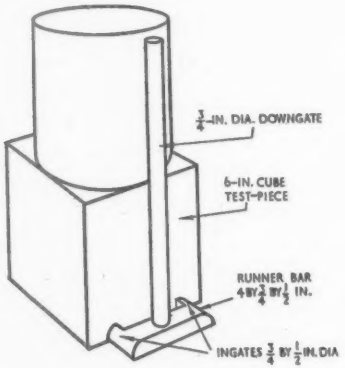


FIG. 1.—*Sketch of 6-in. cube test-block, runners and feeders (diameters of 6-in. high feeders used ranged by 1-in. steps from 2 to 6 in.).*

this contention, for instance, in the work of Ruddle[8] and of Pellini and his co-workers. (The work of the latter is discussed at a later point in the Paper.)

It will be clearly observed from the foregoing that the variables the foundryman has to contend with in shrinkage are often complex and generally numerous, but it is fair to question how many of these variables are controllable, provided good practice is adopted. Mould conditions are well within the control of the foundryman, but it is often with the metal quality, particularly in iron-founding, that the greatest difficulty arises. There would clearly seem a need for a foundry test which is designed to keep several variables constant and yet deals with reasonable quantities of metal. The test should necessarily be simple but not to such an extent that it is entirely divorced from practice and with it the foundryman should be able to reproduce the common types of shrinkage defects which occur in practice and finally, from such a test, be able to establish particular conditions for which these defects disappear.

Theoretical Considerations

Chvorinov Rule and its Variants

The art of feeding of castings undoubtedly goes back to antiquity, so perhaps it is not surprising to note that rules of thumb abound. However, what is surprising is that until recently, quantitative guides, based on something approaching theoretical considerations, have been almost entirely absent. Probably the first (certainly one of the only such guides to be used to any extent by foundrymen) has been the rule of Chvorinov[9]. The rule states simply that the time of solidification of the feeder (t_r) should be equal to, or greater than, that of the casting (t_c) and moreover, that since for the very simplest case;

$$t_c \propto \left(\frac{(V_c)}{(SA_c)}\right)^2$$

where V denotes volume and SA denotes surface area; the volume:surface-area ratio of the feeder should be equal to, or greater than, that of the casting.

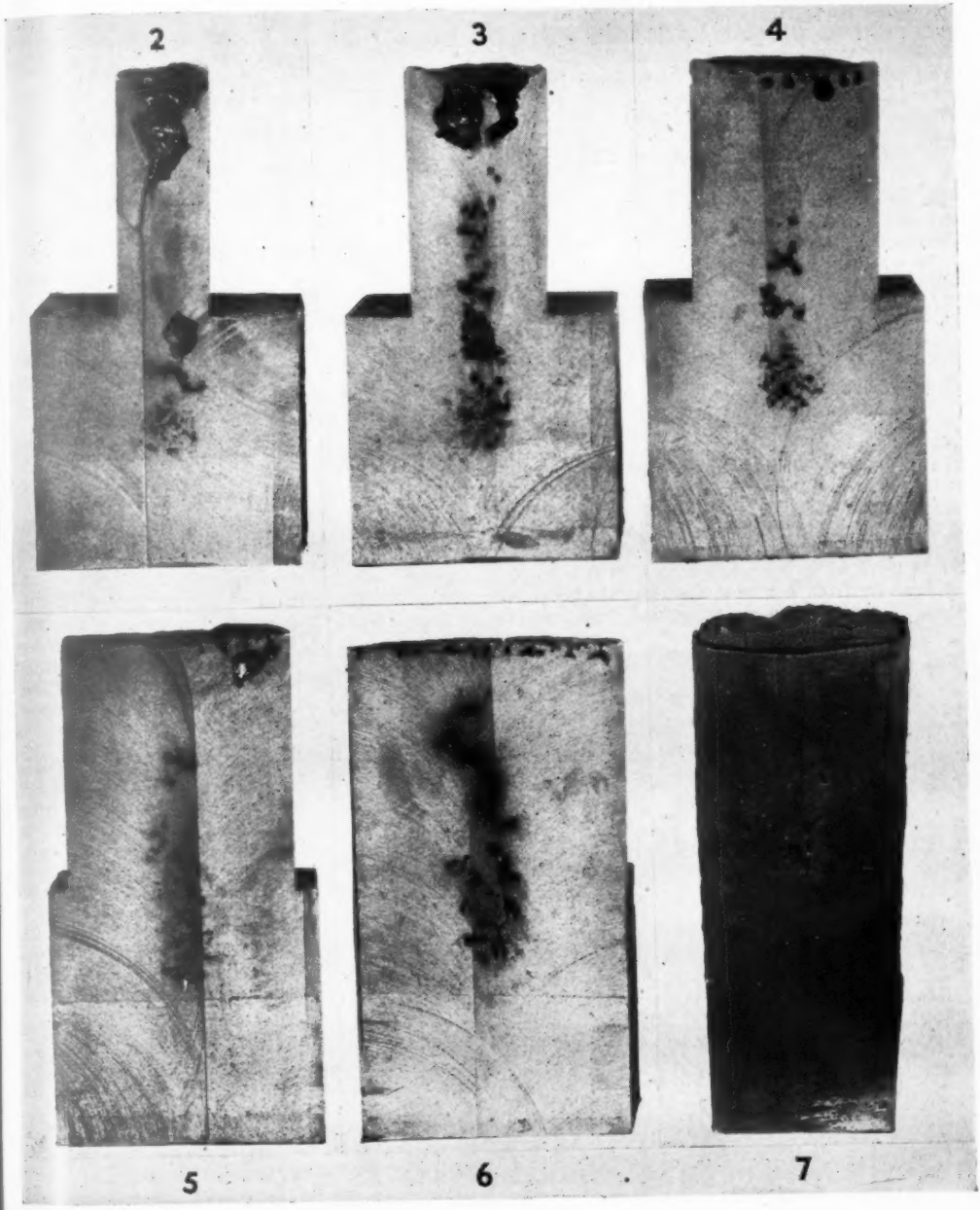
Many objections have been raised against the use of the rule; they may be briefly summarized as follows:—(1) That the solidification time of the casting (or feeder) is not proportional to the square of the volume:surface ratio; (2) that castings are not merely simple shapes; (3) that the long-freezing-range alloys present further complications, and (4) that the criterion of equal solidification times of feeder and casting is insufficient in itself and that any new criterion must take into account "lateral" and "longitudinal" temperature gradients during, and possibly prior to, solidification.

Although both Abcouwer[10] and Halbert[11] have also arrived independently at the proportionality existing between the solidification time and the square of the volume:surface ratio for certain simple shapes, Pellini[12] and Schwarz[13], with their respective co-workers have suggested that the square relationship should be replaced by certain empirically-derived relationships to suit conditions, casting shape and mould respectively. However, these anomalies can be explained by careful consideration of the variables concerned. Most recently, a literature review of this subject has been prepared by Dr. V. Kondic and one of the present Authors (J. T. Berry) in the course of a research at Birmingham University, which has also examined, experimentally as well as theoretically, the effect of several variables on the solidification time of simple shapes[5, 14, 15, 16]. This work has shown how the original mould-constant of Chvorinov[9] may be replaced, or modified, for the various conditions of casting, shape, superheat and moulding and casting media.

Foundrymen have often pointed out that since the rule applies only to simple shapes, it cannot be of any use in the foundry. However, it must be remembered that feeders are nearly always simple in shape so that any effort to relate total solidification-time to the various foundry variables is not wasted. It has been suggested that the Chvorinov rule might be extended to joined sections; however, great discretion must be exercised in such

practice. Pellini and his co-workers have shown in practice how differences of up to 20 per cent. may exist between the solidification times of plain- and joined-plates and also how appendices or parasite

FIGS. 2 TO 7.—*Sections through a range of test-castings with 6-in. high, sand-covered, feeders of increasing size, as quoted in Fig.* 1, *with the exception of Fig.* 7, *which had a feeder* 12-*in. high.*



plates affect the total solidification-time of a particular shape[17]. Not only joined sections present difficulties; indeed it has been shown[5, 18] that strong corner-effects can be exhibited by short cylinders and thick plates, here divergence from the simple rule can be removed by calculating the volume:

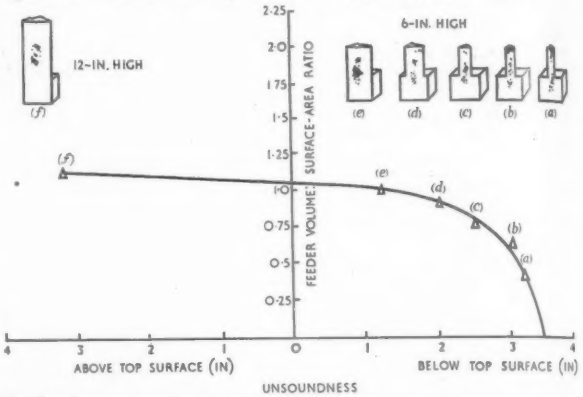


FIG. 8.—*Relation between feeder volume: surface-area ratio and depth of unsoundness (sand-covered feeders).*

effective-surface ratio using a method described by Ruddle and Skinner[18], based on mould calorimetric methods.

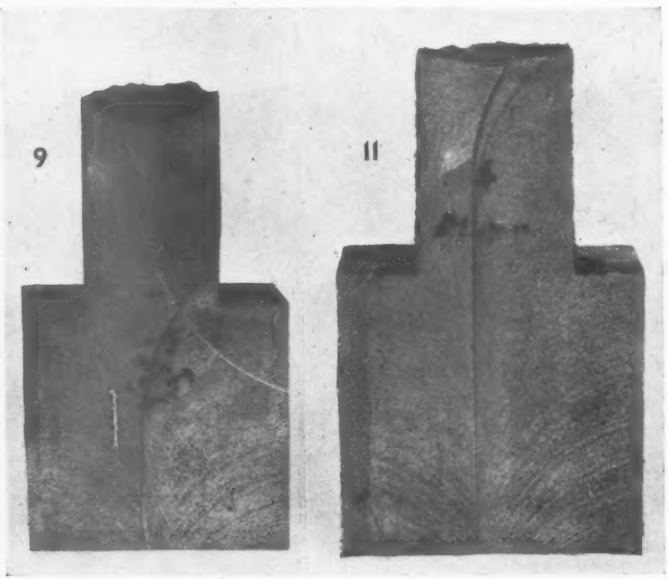
In the case of the long-freezing-range alloys, it has been realized for some time that, in many cases, however excessive a feeder is used, there results only a small change in the amount of micro-shrinkage.

It has often been felt that the Chvorinov criterion alone is not fully sufficient and that a more suitable form would be one involving relative cooling-rates of feeder and casting[19], or alternatively, the temperature gradients throughout the casting prior to, and during, solidification. However, the present Authors feel that such a criterion would only be evolved after a great deal of experimental work and, even so, would not be so readily accessible to the foundrymen as the simple calculation involved in the original rule. Thus, instead of evolving from it a new criterion, the measurement of the appropriate temperature-gradients in feeders and castings, might well be used to determine the usefulness of the Chvorinov rule.

Shrinkage and Temperature Gradients

In the last few years, much valuable work has been carried out at the U.S.N. Research Laboratories under the direction of W. S. Pellini on solidification and the feeding of metal shapes. In addition to those papers already mentioned, particular attention must be drawn to those dealing with the feeding range of risers[20, 21, 22, 23]. These researches have underlined the importance of lateral and longitudinal temperature-gradients, that is, temperature gradients along major and minor dimensions respectively, in bar, plate and certain joined-section castings during solidification in the formation of centreline shrinkage. Much attention was paid to the removal of this shrinkage by positioning of chills and feeders. Briefly, it is suggested that if the longitudinal temperature-gradients near the feeder and at the edge or end of the section considered are separated by a "plateau" or region of constant temperature whilst solidification is being completed, unsoundness will occur at the centre-line. The "plateau" presents the liquid metal with a large central volume of narrow feed-paths between the growing dendrites.

It was felt that these studies could serve as a basis for developing a test by which the *foundryman himself* could



FIGS. 9 AND 11.—*Sections of 6-in. cube test-castings with feeders 6-in. high by 3-in. dia.; covered with exothermic powder (Fig. 9) and with exothermic sleeve ¼-in. thick (Fig. 11).*

evaluate the shrinkage characteristics of a particular alloy and conjointly investigate the importance of temperature gradients in both the feeder and the casting in the formation of centreline- and under-riser type shrinkage. The feeder dimensions would be provided by the Chvorinov rule. In addition it was thought that the test could evaluate the feeding efficiency of a system which, quite plainly, did not obey the simple

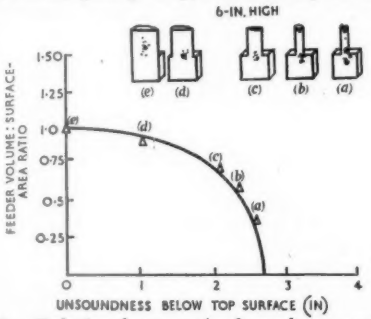


FIG. 10.—*Relation between feeder volume : surface-area ratio and depth of unsoundness (feeders covered with ¼-in. layer of exothermic powder).*

rules of heat transfer which serve as a basis for the Chvorinov rule. Such systems are those surrounded by sleeves of exothermic compounds or those containing breaker cores. Although a previous attempt to apply simple heat-transfer theory[24] to exothermic-cored feeders has been claimed successful, the underlying equation supposedly applying to all cases of shape is the source of one objection in the light of work with which one of the Authors (J. T. Berry) has been associated.[15] The second objection relates to the application of a simple calorific-

FIG. 12.—*Relation between feeder volume : surface-area ratio and depth of unsoundness (with exothermic sleeve ¼-in. thick).*

value of the core, which would appear to take no account of heat-transfer coefficients. Bearing in mind the growing importance of heat-generating [25,26,27] and insulating[9,28] sleeves, such a test could usefully serve as a means of evaluating their efficiency.

Experimental Work

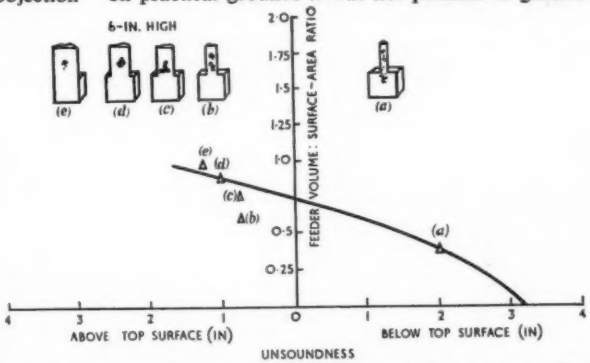
Preliminary Tests

It was felt that preliminary tests using a simple, but large-size, test-casting to check the validity of the Chvorinov rule for the case of one simple shape directly feeding another would prove worthwhile in the light of recent criticisms. In so doing, it was hoped that a very general picture of shrinkage behaviour of the alloy chosen would be obtained. The alloy chosen was a medium-phosphorus cast-iron. (C: 3.35; Si: 1.98; Mn: 0.7; S: 0.12, and P: 0.53 per cent.)

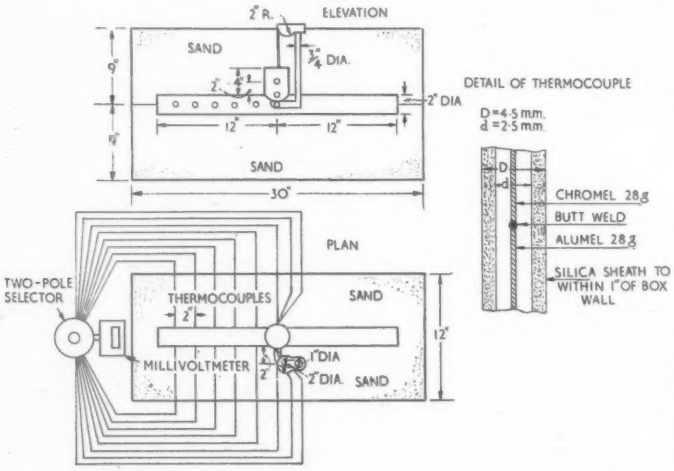
A pattern was constructed for a 6-in. cube which would give a casting of up to 56 lb. It was then decided to formulate a plan of investigation against which the theory could be tested. The test-blocks would be fed by a series of cylindrical shapes all of a constant length but of varying diameters. This would enable a curve to be plotted of volume: surface-area against the effectiveness, or otherwise, of feeder shapes. The best shape to use for feeding purposes for a given weight of metal is the sphere, but it is impossible to eliminate moulding problems with this shape. Therefore, for practical foundry purposes, a cylinder is the shape next in efficiency. (Briggs[29] shows that shapes take the following order of efficiency:—(1) spheres; (2) cylinders; (3) rectangular blocks, and (4) rectangular plates.)

For the experiments to be carried out, the diameters of the various-size feeding-cylinders were arbitrarily determined as follow:—2-in. dia., increasing by steps of one inch for five sizes. Methods of running the test-blocks also came under consideration, and, as intimated earlier, all aspects of these tests should be completely practical, therefore they would be bottom run as in the case of large, heavy castings.

It was also well appreciated that to obtain reliable results, uniformity of general procedure should be made available, sand metal, position and size of downgate and position and size of ingates should all be uniform as far as possible as is shown in Fig. 1. The only factor of those mentioned, where on practical grounds it was not possible to guarantee absolute uniformity, was that of metal. The ideal would have been to pour all test-blocks from one ladle and from a common runner. However, the nearest approach was made and all five were cast from one ladle and poured at as near the same temperature—1,300 deg. C.—as possible. These five test-cubes with their cylindrical feeders were cut lengthways, revealing the whole of the inside of the casting. It was then possible to study the shrinkage that had taken place with each size of feeder used. Actual photographs are shown at Figs. 2, 3, 4, 5, 6, giving a clear impression of the



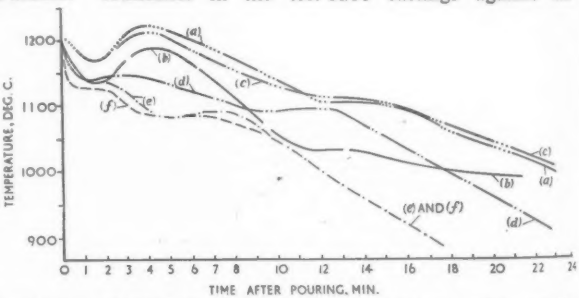
formation of defects. From the illustrations it will be observed that the distance between the casting surface and lowest point of defect gradually reduced as the cylindrical feeder increased. It was now possible to plot on a graph the depth of defect against the volume : surface-area of the feeder (Fig. 8).



None of these five sizes of feeders made a sound test-block, even the largest 6-in. dia. by 6-in. high gave a fair depth of unsoundness. Consequently, an extreme was made, a feeder with a diameter of 6-in. by 12-in. high was used on the 6-in. cube. It must be noted that in this case the metallostatic pressure has been increased, however the Chvorinov rule does not involve this variable. On sectioning, it was found that a sound casting had been produced with unsoundness fairly high up in the feeder.

FIG. 14.—*Temperatures attained in 2-in. dia. 4-in. high cylinders with sleeves of different thickness of exothermic material.*

Key to location: (*a*) 1-in. thick centre, (*b*) 1-in thick interface, (*c*) ¾-in. thick centre, (*d*) ½-in. thick centre, (*e*) ¼-in. thick centre and (*f*) ¼-in. thick interface.



(Fig. 7.) The distance between the bottom of the shrinkage defect and the top of the casting was measured and plotted against the volume : surface-area of the feeder on the graph already prepared (Fig. 8). The points shown on the graph were now joined and where this line crossed the ordinate was the critical volume : surface-area (1.1). Hence, the critical diameter may be calculated, or again, assuming that metallostatic pressure does not play an important part, for a known diameter the required height may be calculated. Thus the volume : surface-area of the minimum feeder required differs only slightly from that predicted by the Chvorinov rule for this particular case of shape.

Further Series of Tests

It was next thought worthwhile to extend this series of tests to conditions to which the Chvorinov rule did not apply. The same series of tests were carried out, but on this occasion exothermic powder was sprinkled on the top of each open feeder to a depth of ¼ in. As previously, each casting was sectioned to examine the depth of unsoundness. In the case of a sound casting, the unsoundness was measured from the line joining the feeder and casting to the lowest point of unsoundness in the feeder. However, in the series, having an exothermic cover, this did not arise, as four of the castings were unsound, those with the 2-in. dia., 3-in. dia., 4-in. dia., and 5-in. dia. feeders were all unsound, whilst the 6-in. dia. feeder gave a sound casting. Fig. 9 gives a photograph of a test-block with a 3-in. feeder. This can be compared with Fig. 3 to show the effect of the method on raising the unsoundness from the casting.

FIG. 13.—*General arrangement of the final test set-up.*

The next step was to plot the depth of unsoundness in the test-cube castings against the volume : surface-area of the feeders. The results of this graph are given at Fig. 10. It will be noted that in this case the feeder that made a sound casting gave volume : surface-area of 1, whilst it will be remembered that the volume : surface-area in the previous test was 1.1.

These tests were taken a step further. The test-cubes were moulded again with cylindrical feeders of the same size, but this time the feeders were sleeved with an exothermic material. The sleeve

was of a uniform thickness of ¾ in. for all five tests and on casting, the metal was covered with a ¼-in. layer of exothermic powder. Again, the test-cubes and feeders were sectioned after fettling, revealing the extent of unsoundness. In this series, only one casting was unsound; that with a 2-in. dia. by 6-in. long feeder, all others were sound. In the plotting of points on a graph in an endeavour to estimate a theoretical feeder-size to feed this cube, the feeder being sleeved with exothermic feeding compound, the process of denoting unsoundness was reversed. Whereas formerly depth of unsoundness was taken from the plane joining the feeder to the casting to the lowest point of unsoundness in the test, this was only done with the feeder of 2-in. dia.

In the other four castings, the unsoundness appeared in the feeder and was measured from the plane joining the feeder to the casting to the point in the feeder where unsoundness first occurred, Fig. 11 shows a photograph of a sectioned cube and 3-in. dia. feeder. The graph showing the plotted line appears at Fig. 12, and again where this line crosses the ordinate is the necessary volume: surface-area of a sleeved feeder needed to feed a cube of this size, this is a volume: surface-area of 0.725. Having obtained this volume: surface-area, the critical diameter can be obtained. Otherwise, assuming metallostatic pressure to be unimportant (as before) one may calculate the height of a sleeved riser of a given diameter. Comparing this result with those of the previous tests, it gives:—

—	Volume: Surface-area Ratio.	
	Casting.	Feeder.
(1) Sand feeder	1.0	1.1
(2) Sand feeder (exothermic cover)	1.0	1.0
(3) Exothermic-sleeved feeder (exothermic cover)	1.0	0.725

This, interpreted for selected feeder sizes, gives:—(1) 6-in. dia. by 8.25-in. high or 6-in. high by 7.13-in. dia. (2) 6-in. dia. by 6-in. high or 6-in. high by 6-in. dia. (3) 6-in. dia. by 1.7-in. high or 6-in. high by 3.25-in. dia. Thus, for a simple shape like a cube of metal, a minimum-size feeder has been extrapolated empirically, which involves considerable metal saving in one case. It must be noted that the Chvorinov rule would appear to be obeyed in the relevant system, that of the sand-covered riser.

Final Form of Shrinkage Test

Disadvantages of Cube Tests.

Unfortunately the cube-type test was not entirely suitable for anything other than preliminary tests, although it had shown validity of the Chvorinov rule for its simple case and also how effective a saving could be had by the use of exothermic sleeving and covering. The disadvantages may be enumerated as follow:—(1) The test does not develop clearly the difference between "centre-line" and "under-feeder" shrinkage; (2) results were biased by the fairly unrestricted action of gravity throughout the system; (3) the large casting was difficult to section and was not, even then, suitable for micro-examination, and (4) corner effects, present in the heat transfer from a cube, present several difficulties in applying any heat-flow theory, such as that upon which the Chvorinov rule is based.

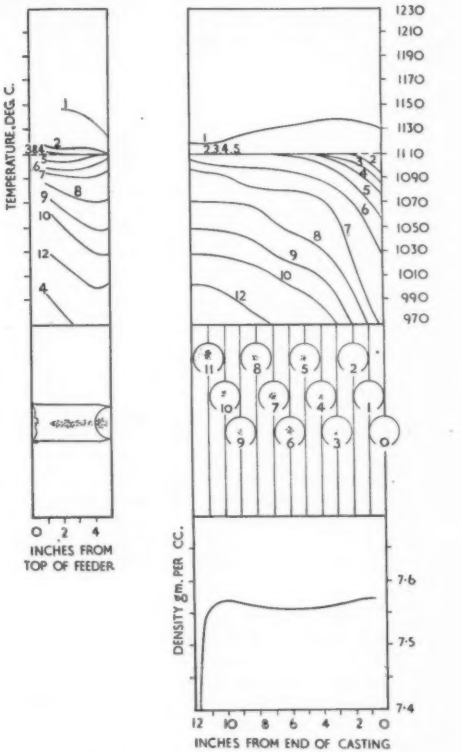


FIG. 15.—*Isochrones at 1-min. intervals, feeder-section, X-radiographs and densities of 1-in sections of bar, with "undersize" feeder, 4-in. high, 2¼-in. dia., sand covered.*

Experiment No. 1 (cast No. 2), ratio V : SA (feeder) < V: SA (casting).

It was thus decided that a jointed section would be more suitable in obviating certain of these difficulties. The exact choice of test-piece was greatly influenced by the work of Pellini and his co-workers, previously discussed.

Experimental Procedure

Basic Test.

The basic form of the test adopted is shown in Fig. 13. Briefly it consists of a horizontal long cylinder, 2-in. dia. by 12-in. long, fed and gated centrally. The feeder and gate also divided the long cylinder into two parts, each experiencing thermal conditions as nearly identical as possible; one containing thermocouples at regular intervals

for recording thermal history, whilst the other was to be sectioned and examined after cooling to room temperature. Thermocouples were also accommodated within the feeder, at its base and its geometric centre. Gating was standardized for all experiments as a side gate in the parting line. Moulding boxes used were sufficiently large to ensure that four to six inches of sand surrounded all points on the surface of the casting and the feeder.

Materials.

The materials chosen as casting and moulding media were as follow:—

Castings in a medium-phosphorus grey-iron. Individual analyses of bars are given in Table I, however, the following is typical of the range of composition encountered during the period in which the test-castings were made: C, 3.11 to 3.26; Si, 1.7 to 2.18; Mn, 0.74 to 0.83; S, 0.09 to 0.15; P, 0.04 to 0.79; and Cr, 0.07 to 0.11 per cent. The pouring temperature was approximately 1,300 deg. C., and was measured by a noble-metal immersion thermocouple. Pouring times were standardized to 30 secs.

Moulds in a typical medium-grain, naturally-bonded, red (Bunter) sand, were rammed carefully by hand in layers, such that the surface hardness of each layer was approximately 70 units over most of its width and length. Moulds were cast " green " at 6½ per cent. moisture. Certain special mould-materials or compounds were used as feeder insulating/heating agents; these are considered later.

Recording of Data.

Recording of time/temperature data was carried out by means of a multi-point selector switch of the double-pole variety, which channelled any of the thermocouple outputs into a portable 0-60 mv millivoltmeter. Thermocouples employed were butt-welded 28 gauge Chromel/Alumel. These were sheathed within the casting—as well as the greater part of their length within the mould—by thin silica quill of 1.0-mm. wall and internal diameter 2.5-mm. Insulation from this point to the compensating leads was either silicone-impregnated, glassfibre hose or simply cellulose paint. A metal-sheathed mineral-insulated thermocouple of 24 gauge wire was bent suitably so that the temperature at each feeder centre could be measured. Readings of temperature were taken in strict rotation at intervals of 5, 10 or 15 secs. according to the average cooling rate of the casting.

TABLE I.—*Percentage Composition of Bars used for Tests.*

	C	Si	Mn	S	P	Cr
Expt. (1) Under-size Risered Bar						
Cast one	3.33	2.18	0.81	0.09	0.56	0.11
Cast two	3.26	2.07	0.83	0.11	0.79	n.d.
Expt. (2) On-size Risered Bar						
Cast one*	2.73	2.20	0.78	0.09	1.03	n.d.
Cast two	3.22	2.03	0.83	0.11	0.77	0.07
Expt. (3) Bar with Sleved-Riser (Exothermic) ..	3.10	1.71	0.75	0.15	0.40	0.08
Expt. (4) Bar with Sleeved Riser (Diatomaceous-earth)	3.13	1.91	0.78	0.11	0.48	0.07
Expt. (5) Bar with Sleeved-Riser (Erith Loam) ..	3.11	2.07	0.74	0.11	0.60	0.0
Expt. (6) Oversize Risered Bar	3.22	2.04	0.83	0.10	0.57	0.07

* One cast only was made in this iron (a common, engineering, high-phosphorus iron).

Determination of the relative amount and types of unsoundness at various parts of the casting was carried out in the following ways:—

(*a*) Feeders were sectioned in a vertical diametric plane and the section then photographed;

(*b*) the parts of the bar not containing thermocouples were sawn in the vertical plane at one-inch intervals. These were then subjected to examination in one, two or three of the following ways:—

(1) Sections were ground by machine and then finished by hand to 000-grade emery. After a low-power microscopic examination, the sections were photographed where this was deemed necessary.

(2) X-radiographs were taken of each individual section. Lead-screening was provided around each specimen in the form of thick sheeting, punched with 2-in. dia. holes.

(3) Density estimations were carried out on certain bars. Highly-porous specimens were lacquered before weighing when immersed.

Plan of Experiments Carried Out

It was decided that using otherwise standardized conditions, the efficiency of certain feeder-types should be evaluated for an alloy of fairly-high shrinkage-characteristics, namely, a medium phosphorus grey-iron. The choice of feeder types was based upon the Chvorinov criterion of the equality of solidification times of feeder and castings, each being treated as a *separate* mass.

Conditions Investigated.

The conditions investigated were as follow (when t_s is solidification time in sec. and V : SA is volume : surface-area ratio):—

	Feeder	Casting	Feeder	Casting
Expt. 1. Plain-sand blind-riser (two casts UR 1 and UR 2) 2½-in. dia.	t_s	$<$ t_s	V : SA	$<$ V : SA
Expt. 2. Plain-sand, blind-riser (two casts OR 1 and OR 2) 2½-in. dia.	t_s	$=$ t_s	V : SA	$=$ V : SA
Expt. 3. Exothermic-sleeve, blind-riser; 2-in. dia.	t_s	$=$ t_s	V : SA	$\neq$ V : SA
Expt. 4. Diato-maceous - earth sleeve: blind-riser, 2½ in. dia.	t_s	$=$ t_s	V : SA	$\neq$ V : SA
Expt. 5. Erith-loam sleeve, blind-riser 2½ in. dia.	t_s	$=$ t_s	V : SA	$\neq$ V : SA

All feeder heights were standardized to four in. The volume : surface-area ratio of a feeder surrounded by insulating material, necessary to provide the riser with a solidification time equal to that

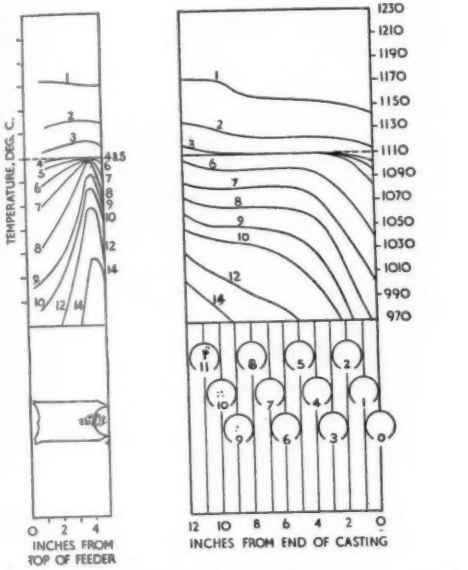


FIG. 16.—Experiment No. 2 (cast No. 2) ratio V : SA (feeder) = V : SA (casting); sand-covered feeder 2½-in. dia.

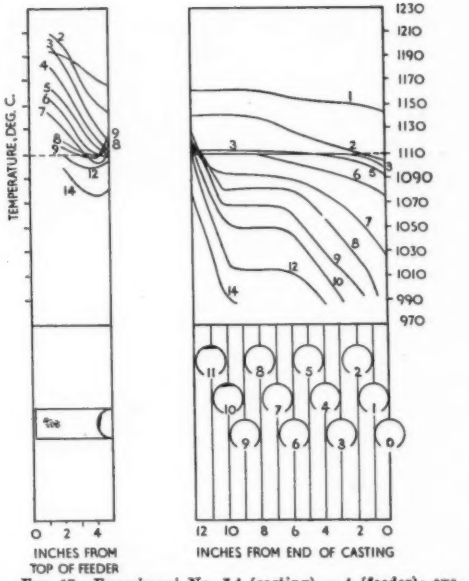


FIG. 17.—Experiment No. 3.t (casting) = t (feeder); exothermic sleeve feeder, 4-in. high, 2-in. dia. sleeve thickness ¼-in.

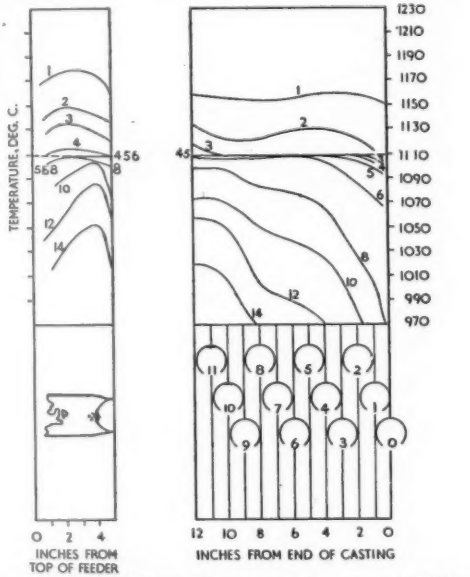


FIG. 18.—Experiment No. 4.t (casting) = t (feeder); diatomaceous-earth-sleeve feeder, 4-in. high, 2½-in. dia. sleeve thickness 1¼-in.

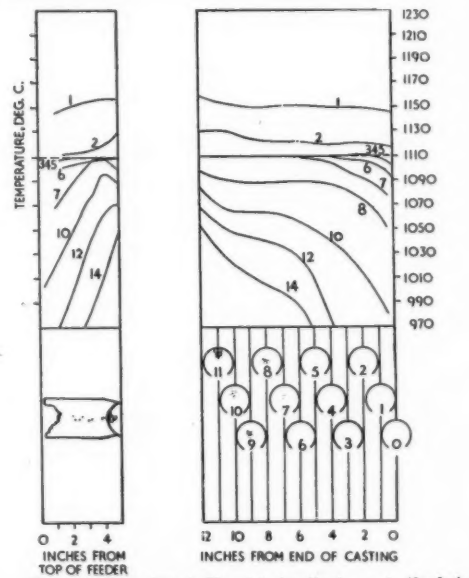


FIG. 19.—Experiment No. 5.t (casting) = t (feeder); Erith, medium-loam-sleeve feeder, 4-in. high, 2½-in. dia. sleeve thickness 1¼-in.

FIGS. 16 TO 19.—*Feeder section and isochrones at* 1*-min. intervals and X-radiographs of* 1*-in. sections of test-castings for various feeder conditions as detailed.*

of the casting, was calculated using a method developed from the Chvorinov rule by one of the Authors (J. T. Berry) in association with Dr. V. Kondic and Dr. G. Martin[15].

Since the thermal conditions prevailing in and around feeders sleeved in exothermic media *do not permit* the use of *simple* heat-flow formulae, it was decided that certain preliminary experiments would be necessary to determine the minimum thickness of such a sleeve to provide a given shape, 2-in. dia. by 4-in. high, with a solidification time equal to that of the casting. To this end, four cylinders 2-in. dia., 4-in. high mounted on a ½-in. dia. sprue were moulded, one or two thermocouples being accommodated in each cylinder. Around the cylinder were exothermic sleeves with lids of various thicknesses. The temperature/time records obtained are shown in Fig. 14 ; from these, a sleeve thickness giving the solidification time required was decided upon (⅜-in. thick).

Results and Their Presentation

The results of the temperature-recording experiments are shown as isochrones along with diagrammatic representations of unsoundness throughout the bars and feeders in Figs. 15 to 19. From the radiographs obtained it was noted that in repeat casts of experiments 1 and 2, unsoundness defects were almost exactly reproduced irrespective of analysis difference. In addition, a density survey was carried out on the bar with undersize feeder. It was felt that since such a method depended greatly upon the accuracy of a large balance and was not thoroughly satisfactory for highly-porous sections and finally was particularly time consuming, it should only be used for a few limited instances.

Comments

Application of the Test to Cast Iron

The difficulty of deciding on an end point of solidification in the thermal analysis of cast irons has been recognized previously[4, 30]. Recently, Gittus and Hughes[30] at the British Cast Iron Research Association have established the relation between thermal-analysis and solidification-progress as indicated by the quenching of castings. The work showed that, particularly in the case of their grey-iron of high-phosphorus-content, solidification of the graphite/austenite eutectic continued down to temperatures well below the "knee" of the time/temperature curve ; in fact this solidification was only 62 per cent. complete at temperatures of almost a hundred degrees below the so-called eutectic "arrest." A second interesting conclusion drawn by these workers[30]—a conclusion which might possibly be inferred when one examines earlier work of Ruddle and his co-workers[31, 32]—was that a particular temperature does not necessarily represent a particular stage of solidification.

These difficulties present themselves when one attempts to apply to a cast iron the condition of Pellini[20] *et alia* which states that "centreline" shrinkage occurs in certain castings at points along their longitudinal axes which are connected by a constant temperature "plateau" at the *end* of solidification. Thus, it would seem that for as complex an alloy as a medium-phosphorus, hypo-eutectic grey-iron, where the solidification of three systems must be considered (primary γ, γ/graphite and γ/graphite/phosphide); this condition is not entirely applicable. This is particularly clear when one observes that longitudinal temperature "plateaux" (*a*) exist during a solidification range, and (*b*) disappear at the end of the range, for the bar lengths exhibiting both the presence and the absence of "centreline" shrinkage. Therefore, it seems probable that these "plateaux" can be tolerated during solidification and hence, commercially-sound castings can be made; providing the adjoining mean longitudinal gradient, in particular that at the foot of the feeder, is sufficiently steep.

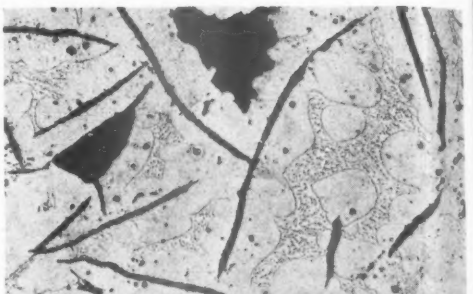


FIG. 20.—*Shrinkage associated with phosphorus-rich areas at the foot of an "undersize" feeder,* ×150.

In addition, the reversal of temperature-gradient at the foot of the feeder must not be neglected when considering centreline shrinkage; with the underfed bar (Expt. 1, Fig. 15) this gradient soon becomes unfavourable to feeding the casting. For the first five to eight minutes, feeding probably takes place *both* into the feeder-head and the casting, since capillary action must not be disregarded in such a wide-freezing-range alloy as that under consideration. Although the temperature-gradient eventually steepens with time in the upper part of the feeder, this probably only serves to supply metal to the centre portion of the feeder, since this steepening does not remove the initial reversal of gradient at the bottom of the feeder.

Appreciation of ideal conditions of feeding is somewhat complicated by the apparent part-dependence on temperature of the rate of eutectic-cell nucleation and growth, since Gittus and Hughes[30] have shown that, in the earlier parts of the eutectic solidification, cells form and commence growing at different parts of the same casting at quite different temperatures. Thus, the general picture must include (*a*) the desirable partially-liquid metal with, adjacent, a volume of liquid containing fewer cells

(as in the instance of a feeder providing a steep gradient at its foot), as opposed to (*b*) adjacent volumes of partially-liquid metal with roughly equal numbers of cells, and therefore, equal numbers of obstacles to the feed-path (for instance, the feeder with a flatter temperature-gradient at its foot).

When the cases of under-feeder-type shrinkage are considered, one is immediately reminded of the value of the "hot-spot" locating-technique as provided by Heuver's circles. It must be noted that only in the instances of the exothermic and one of the insulator-sleeved feeders, was an approach to removing under-feeder shrinkage established. Generally, the thermal centre of each system was insufficiently high in each feeder to eliminate the defect. It was felt that the effect of increasing the feeder diameter further should be investigated as it has been suggested that in practice, too large a feeder can be applied to a casting. Therefore, an extra test-bar was made with a 3-in. dia., 4-in. high feeder. Sectioning of the feeder and the casting showed that the thermal centre was still below the geometric centre of the former, so that the practical hazards of over-feeding are confirmed in this instance. Thus, the ideal feeder must be founded upon another means for shifting the thermal-centre upwards.

It is interesting to note that the actual form of the under-feeder shrinkage appears to depend upon certain other factors besides temperature gradient. The defects formed in the castings with the exothermic-sleeved feeder, the diatomaceous-earth-sleeved feeder and the oversize-feeder are rather different from those of the other castings (particularly the first two). It is suggested that in these instances the wide freezing-range combined with the slower cooling-rate of the feeder has resulted in the atmosphere collapsing the wall and helping to consolidate feeding of the bar.

Bearing in mind the ultimate control of both under-feeder and centreline shrinkage, the use of the necked-down feeder or possibly a feeder with only its upper sides and top surface surrounded with an exothermic compound would seem to be indicated rather than a feeder of greater height; since such a feeder should fulfil the dual rôle required in providing the necessary thermal-gradients and supply metal to combat both types of defect.

Suitability of the Test.

Although at first sight, interpretations may seem somewhat obscure, the test in its final form has made temperature conditions known; in the few feeding systems investigated—and with which certain shrinkage defects coincide—the types of shrinkage occurring in practice being "centre-line" shrinkage and under-feeder shrinkage of two main types; one open and the other closed to the atmosphere. The latter type of shrinkage is generally seen on sectioning, whilst the former is often not clearly seen until a low-power microscopic examination of a section is made, or alternatively an X-ray examination is carried out. It must be stressed that the latter form of examination is not essential. Alternative methods of showing the presence of this type of defect are density measurements or an acid-etching technique.[33]

Regarding the guidance provided by the Chvorinov rule, it is interesting to note that its simple dictates do appear to be capable of eliminating centreline shrinkage, or at least reducing it to a low level. However, in this particular alloy, it does not ensure the absence of under-riser shrinkage. It may well be that with metals (particularly steel and the light alloys) in which "mass feeding" readily takes place,[34 35] the Chvorinov rule might be more successful in reducing this defect.

At present, it would appear that the cohesivity of the products of the eutectic solidification, combined with the long range of solidification, play some considerable part in preventing this "solid feed"[35] in certain cast-irons. In addition to the apparent absence of this phenomenon, it might be felt that the feeding action towards the end of the eutectic and the beginning of the phosphide-eutectic solidifications is relatively difficult; however, it is of interest to note that in the under-fed bar (0.79 per cent. P), phosphorus contents determined at points at the foot of the feeder (1 in. above the casting centreline) was less than that at the casting centreline by 0.08 per cent. (*i.e.*, 0.76 and 0.82 per cent. P, respectively). Taking into account that (*a*) the accuracy of the analytical method was 0.005 per cent. and that (*b*) at a point equidistant between the feeder and the end of the bar, the phosphorus contents at the centre and edge were 0.79 and 0.79 per cent., respectively, it would appear that the last volumes of liquid to solidify (which will be phosphorus-rich), do take some considerable part in supplying metal to compensate under-feeder shrinkage. Microscopic examination of such an area confirmed this movement[22] (Fig. 20).

Thus, the use of this test with various alloys of differing "mass-feeding" characteristics, should provide interesting information on the usefulness of Chvorinov's rule. In addition, it is visualized that the efficiencies of more-specialized feeding systems, in particular alloys, for example "necked-down" and Washburn-cored types, might profitably be investigated by any foundryman willing to invest in the few pieces of equipment necessary.

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Publications Received

Battersea Works—1856-1956, written by Richard Bennett, and published by the Morgan Crucible Company, Limited, Battersea Church Road, London, S.W.11.

Before commenting on this well-produced, 68-page history of the company, the reviewer would like to add his congratulations to the very many which must have been received. It appears that the origin of Morgan's was the acquisition of manufacturing rights from Joseph Dixon & Company, of Jersey City, for the production of crucibles. An interesting account is given of a firm of city wholesale druggists and hardwaremen acquiring a physical one-horse-power workshop at Battersea village, and its modernization. Success was such that by 1872 one of the Morgan brothers lost £100,000 on the turf but won the St. Leger with his Hawthornden. There are interesting chapters on the history of the crucible and the graphite mines of Ceylon, India, and quarries in Madagascar. Then come two chapters on salesmanship, and therein lies a good lesson on the subject. So far as present times are concerned, the company is supporting the technical training of salesmen not only in their own works, but through special courses on foundry practice organized by the Borough Polytechnic. There is one surprising omission from the book, and that is the lack of any reference to their recently-equipped research department. It would be interesting to learn whether at the birth of the electric furnace, Morgan's ever thought of manufacturing electrodes. Possibly it was due to the incidence of the 1914 war and probably the high cost of electricity in this country that such a project was not developed.

When completing the history of the works, it is obviously more difficult to know what to omit rather than what to print, but it must be conceded that the author has struck an exceedingly good balance in this publication.

Transactions of the Manchester Association of Engineers, 1953-54. Published by the Association from 20, Booth Street, Manchester, 2. Price on application.

This year the Manchester Association of Engineers celebrates the centenary of its foundation, and the presidential address by Dr. H. Wright Baker happens to be appropriate to the occasion though presented a few years too early. This address is outstanding, as it is full of "wise saws." A paper of interest to foundrymen is "Formation and Prevention of Atmospheric Contamination in Factories," by Mr. W. A. Attwood and Mr. W. B. Lawrie.

India—a Survey for British Industrial Firms. Published by the Federation of British Industries, 21, Tothill Street, London, S.W.1; price 4s. 6d.

India is a complex country but one which does an enormous business with the UK. That is a good reason why the complexities of trading with that country should be understood, and every manufacturer interested and any technologists envisaging employment in India should study the book with care. Income tax in that country makes employment there much less attractive than formerly. This applies with equal force to Indian technologists. The remarks which Mr. Stephen Garvin, the author of this booklet, has made on page 37 will cause technical men to accept only short-time (two years) employment contracts. For British businessmen, the best policy seems to be to operate branch establishments themselves, especially as the old-established managing agencies are to have the number of agencies which they operate limited. The booklet can be recommended wholeheartedly for study by any concern or individual having commercial and industrial relations with India.

FIVE new service and spare-parts centres have been established in Germany by F. Perkins, Limited, diesel-engine makers, of Peterborough, to augment its present service arrangements.

Chemistry and Industry

Research into Corrosion and other Problems

The extent to which nearly all forms of activity, industrial and otherwise, to-day, depend on chemistry in various degrees, may be gathered from a study of the Report of the Chemistry Research Board for 1955 recently published (HMSO, price 4s.). A clear indication of the usefulness of the laboratory, it is stated, is the large and growing advisory service resulting in severe demands upon the time of senior officers in drafting replies to technical enquiries, in receiving visitors for discussion, and in making visits to examine problems on site. It is significant that nearly one-fourth of the scientific staff of the laboratory is engaged on work for the United Kingdom Atomic Energy Authority. The main researches are concerned with evaluation and treatment of minerals, ores and other materials containing valuable metals, by the improvement and development of new techniques for analysis, and by study of methods of extraction and concentration of the metals present.

On the analytical side, field methods for the determination of trace metals in soil have been applied by a number of prospecting companies and reported on favourably. The range of metals covered by this method has been extended, and recently beryllium, chromium and bismuth have been added. Much of the research effort has been concerned with the extraction and recovery of uranium and thorium from mineral deposits in various parts of the Commonwealth. Studies undertaken on behalf of a mining company have led to the development of a direct chlorination process for the recovery of niobium and vanadium from ore taken from a deposit in Kenya.

Metal Purity

Present-day studies of semi-conductors have created a demand for elements in a state of purity much higher than that hitherto required. Therefore, a study has been commenced of the purification of some of these elements. The use of zone refining as a means of purification has been examined for some of the lower-melting elements such as bismuth, gallium, indium and tellurium. The Pure Metals Committee has drawn the Board's attention to the need for a special group of workers to undertake not only the difficult and time-consuming work involved in providing analyses of pure metals but also, in view of the growing demand for still purer metals, research on the determination of trace impurities in elements. It is therefore strongly recommended that an analytical group should be set up within the Department of Scientific and Industrial Research to study, in the first instance, applications of the solid-source mass spectrometer in new methods of analysis. Authority has already been given for the purchase of this instrument.

In corrosion research the effort has been concentrated on the study of corrosion inhibitors, the development of improved methods of tarnish prevention, and the study of corrosion and its prevention at high temperatures. Radioactive tracer methods have proved valuable in the quantitative study of the thin invisible films that inhibit the corrosion of mild steel in potassium chromate solution. The growth of these films is very similar to that of the oxide film when mild steel is exposed to air. In both cases corrosion is prevented only if the film continues to build up uniformly, either as a composite film of chromic and iron oxides in chromate solution, or as an iron oxide film in air. Transference, for instance, of the steel from chromate solution to distilled water leads to breakdown of the film. An exact knowledge of the conditions in which these films are formed is fundamental to the study of corrosion inhibition and to the development of the more effective inhibitors required in industrial plants, states the Report. Further study of soils known to be non-aggressive towards iron and steel has revealed the presence of a substance, not yet identified, that inhibits the activity of the sulphate-reducing bacteria that are responsible for the rapid corrosion of buried structures in water-logged clay soils. The available evidence suggests the existence of an antibiotic substance in non-aggressive soils, more potent than the tannins previously studied.

Sulphate-reducing bacteria have been studied at the laboratory since 1933, chiefly because of their importance in the corrosion of buried metals and in polluted waters, *e.g.*, wet pits used for refuse disposal, and the water bottoms of gas and petrol storage tanks. Recently, because the United Kingdom largely depends on imports for its sulphur supplies, these bacteria have been studied for their potential use in the production of hydrogen sulphide and hence, sulphur or sulphuric acid, from indigenous materials.

Chemical engineering research is to receive more attention, experimental work being first concentrated upon the dispersal of gases in liquids.

Overseas Iron and Steel Statistics

The British Iron and Steel Federation's "Statistical Year Book for 1954" has just been completed by the issue of Part II, which deals with overseas countries. The delay has been occasioned by late arrival of statistics from certain sources. Part I, which deals with United Kingdom statistics of iron and steel production, imports, and exports, was published about a year ago. These two volumes together present a detailed compendium of world iron and steel statistics. During the past 12 months certain figures for 1955 relating to the world as a whole have become available, and these have been included in the volume now published. As usual, a number of improvements, suggested by experience in the use of the Year Book, have been incorporated, although mainly in matters of detail. Attention, however, should be drawn to the additional tables showing world trade in iron ore and in iron and steel scrap. Certain additions also have been made to the maps, which are a feature of this overseas volume. Copies may be obtained from the British Iron and Steel Federation, Steel House, Tothill Street, Westminster, London, S.W.1. (Price 15s.)

Industrial Disputes in Half-year

In the first half of this year, stoppages in industry have caused a loss of 1,120,000 working days, according to the "Ministry of Labour Gazette." Of this total 259,000 days were lost through disputes in the coal-mining industry. Disputes in the printing industry cost about one-third of the total, while the vehicles section was also to the fore with a loss of 164,000 days. Even so, the loss in the first half of this year was less than half of that of 2,810,000 in the first six months of 1955. Latterly the dispute of the steel maintenance craftsmen has been the main source of lost days. The overall total for June was a cost of 138,000 days, compared with 181,000 in May and 1,330,000 in June, 1955.

Wage increases averaging 10s. a week have been awarded to 11,400,000 workpeople in the first half of this year at an estimated cost to employers of £298,000,000 a year. In June, however, the index of wage rates (June, 1947 = 100) was constant at 164, the same as the May figure.

The normal seasonal fall in unemployment has been smaller this year than last—41,000 in the first six months, against 88,000 in 1955. The total in June was slightly higher than a year earlier, but there were still nearly twice as many vacancies as unemployed.

The July Treasury "Bulletin for Industry" says that although activity in the capital goods industries increased this year, employment in the metal engineering and vehicle group fell by 38,000 in the first five months, compared with last year's gain of 82,000. But the basic industries increased seasonally by about the same amount as last year. The total working population fell 43,000 up to May this year, whereas last year and the year before there were rises of 50,000.

The Central Statistical Office estimates that the production index (1948=100) in June was 139-140, a record for the month. The figure for May was 135 and 137 for June last year, but comparison is misleading in this case, however, as output in June, 1955, was seriously affected by the railway and dock strikes. After making allowance for holidays and other seasonal factors, the office has adjusted the index for June this year to 135-136, compared with 135 in the same month last year, and that for May to 134. With seasonal adjustments the average index for the first half of this year is shown to be one half of 1 per cent. higher than for the corresponding period of 1955.

GTMA Delegation for US

With a view to promoting the export of British tools and gauges to the United States, a delegation of directors of member firms of the Gauge and Tool Makers' Association is visiting the US next month. Apart from calling upon prospective buyers in the big cities, the delegation will also attend the Exposition and Convention of the American Association of Iron and Steel Engineers in Cleveland from September 25 to 28. The party sails from Southampton on September 6 and will return from New York on October 3.

The association announces that as member firms' requirements of space can no longer be accommodated in the New Horticultural Hall, Westminster, at which the previous exhibitions have been held, the next Gauge and Tool Exhibition, in May, 1958, will take place in the National Hall, Olympia, London.

British Road Services Reorganization

The following plans for the organization and operation of British Road Services consequent upon the Transport (Disposal of Road Haulage Property) Act, 1956, which has just received the Royal Assent, have been announced by the BRS board of management.

Company Structure

The Transport Acts, 1953 and 1956, require the vehicles to be operated through the medium of limited companies, and business will accordingly be conducted through five operating companies as from September 9, *viz.*:—

Company	Vehicle strength (approximate)
British Road Services, Limited (operating general haulage) ...	7,750
B.R.S. (Pickfords), Limited (operating special traffics and some contracts)	1,350
B.R.S. (Contracts), Limited ...	1,000
B.R.S. (Parcels), Limited	4,400
B.R.S. (Meat Haulage), Limited ...	500

The shares of these companies will be owned by the British Transport Commission. Those of B.R.S. (Parcels), Limited, and B.R.S. (Meat Haulage), Limited, are still subject to disposal, but the new Act makes it possible for the sale to be deferred for the present, with a view to the trading position being firmly established. Meanwhile, they will be operated as commercial units to the best possible advantage.

The general pattern of executive management will remain unchanged, the country being divided into six geographical divisions—South Eastern, Scottish, North Western, North Eastern, Midland and Western—together with one division, Pickfords, for special traffics. A divisional manager will be in charge of each of these divisions, controlling and co-ordinating all BRS activities, except Pickfords, within his territory. Below divisional level, the BRS general haulage company will operate through 25 districts, and B.R.S. (Parcels), Limited, through eight area organizations; BRS will have local branches in all important centres. All services will be operated under the trading name of British Road Services.

Boulton and Watt Relics

Properties associated with Matthew Boulton, of the Soho Foundry, have been bequeathed, under the will of Miss Jane Margaret Thomas of Aberystwyth, to the "Boulton and Watt Institute," Birmingham. They consist of camp drawers which dismantle to form two suitcases. There is, however, no "Boulton and Watt Institute" in Birmingham, although it is not expected that the fact will prevent the city authorities from accepting the bequest.

There are many Boulton and Watt relics housed at various places in Birmingham. The Birmingham Reference Library has a large collection of papers and documents associated with the two men; some other relics, mainly of engineering interest, are at the Birmingham Museum of Science and Industry, Newhall Street. Furthermore, some drawing instruments which the Soho men used are kept at the James Watt Memorial Institute, Birmingham. Watt's workshop which was taken from his Handsworth house, Heathfield Hall, is now at the South Kensington Science Museum, London.

Brinell Hardness Testing*

By J. Léonard

On the evidence provided by a number of practical comparative tests on bars and castings, the Author chooses the 2.5 mm./187.5 kg. combination of ball and load for Brinell hardness testing. Used on machinable grey-iron castings, it is claimed that this combination permits accurate reading, testing close to an edge, impressions close to one another, appreciation of scatter, and good average results.

To be comparable Brinell hardness numbers should be obtained through the use of ball diameter and a test pressure conforming to the relation:— $\frac{P}{D^2} = K$

The three sets of test conditions used in this connection give:—

$$\frac{P}{D^2} = \frac{3{,}000}{10 \times 10} = \frac{75_0}{5 \times 5} = \frac{187{\cdot}5}{2{\cdot}5 \times 2{\cdot}5} = 30$$

The hardness numbers these combinations of ball diameter and test pressure will give are thus comparable. This coefficient of 30 is generally agreed upon for ferrous metals (steel and cast iron); but some standards demand the ratio 10 for non-ferrous metals and their alloys (bronze and brass). As the alloy becomes softer, so the coefficients are lowered. Table I gives for three ball diameters, the load to apply for various coefficients ranging from 30 to 0.5. Such tables or graphs permit the conversion of hardness numbers obtained under one set of conditions to others.

TABLE I.—*Load in Kg. in Relation to Various Coefficients for Ball Diameters and Loads when Brinell Testing.*

Ball diameter in mm.	30 D^2.	10 D^2.	5 D^2.	2.5 D^2.	1.25 D^2.	0.5 D^2.
10	3,000	1,000	500	250	125	50
5	750	250	125	62.50	31.25	12.50
2.5	187.50	62.50	31.25	15.625	7.8125	3.125

* Translated from *Fonderie Belge*.

Choice of Ball Diameter

For any given thickness (*e*) of the test-piece or the casting to be tested, the diameter of the ball should be chosen to avoid the deformation of the opposite face. The relation: *e* minimum = 3 *d* when *d* is the diameter of the impression, is recommended. At the same time, to avoid lateral deflection, the distance between the centre of the impression and the edge of the casting must be equal or greater than 2 *d*, likewise according to specification, the minimum distance between two neighbouring impressions should be 2 *d* or 3 *d*.

These two factors govern the choice of ball diameter, which becomes smaller as the casting or test-piece decreases in size, or again where it is desired to measure the hardness of a zone which approaches nearer and nearer to the edge of the surface. Again, the more the material is heterogeneous, the better the small ball shows up variations in local hardness. A ball of large diameter applied to a larger surface represents the average nature of a number of hardnesses at that point. Either the amplitude of the local variations can be determined or preference can be given to an average figure. A very wide dispersion of the results given by a small ball should be ascribed to the inherent irregularity of the material tested and not to any weakness of the test itself. Thus, use of the small ball and the low load which, permitting direct reading on a large screen, appears to offer an assurance of exactitude and of precision in the measurement of the diameter of the impression.

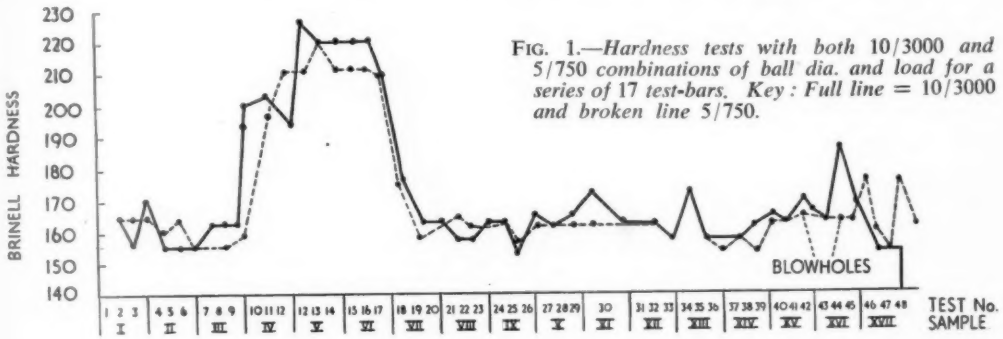

FIG. 1.—*Hardness tests with both* 10/3000 *and* 5/750 *combinations of ball dia. and load for a series of* 17 *test-bars. Key: Full line* = 10/3000 *and broken line* 5/750.

Brinell Hardness Testing

5 mm./750 kg. Testing

During the first European foundry exhibition held in Paris in 1913, the Author was authorized by the Fabrique Nationale d'Armes de Guerre de Herstal (Belgium) to participate with others in obtaining optimum results from a cupola, involving the control of each tap of iron by the hardness testing of separately-cast samples. Both the 10/3,000 and 5/750 tests were sanctioned, the former being carried out in the central laboratory and the latter in the divisional foundry laboratory which was convenient for the Author's purpose, but he doubted the agreement of the results in view of the heterogenity of the iron. Comparative tests were therefore organized and the curves shown in Fig. 1 were produced; they give for each test numbered I to XVII (each an average of tests on three bars, the hardnesses given by both the 10/3,000 and the 5/750 combinations. For the two types of irons cast, the

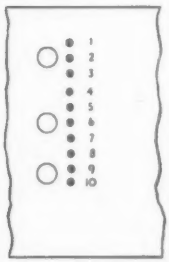

FIG. 2.—*Relative positions of the* 10/3,000 *and* 2.5/187.5 *tests quoted in Example* 3.

hardness figures varying from about 160 to 210, the results were practically identical. The scatter of results obtained from 5/750 was much the same as that from the 10/3,000. The 5/750 were passed as satisfactory. A recent research undertaken by the Fabrique Nationale, the results of which were given to a Belgian foundry, has reawakened the Author's interest in this matter and substantiated the previous findings.

2.5 mm./187.5 kg. Testing

A research in connection with establishing a control method—not so much of the quality of iron cast but more to obtain regularity over a period has been carried out by a light iron castings foundry with the object of comparing the results given by the 2.5/187.5 with the 10/3,000 and also with the Rockwell $\frac{1}{16}$-in./100 kg. ball and load combinations. The latter did not conform to the ratio $\frac{P}{O^2} = 30$, but conversion tables permitted the establishment of the ratios. Table II shows the results of testing different places of the same casting. The 2.5/187.5 gives at A and B values lower than those of the 10/3,000. The Rockwell machine, surprisingly, acts satisfactorily in relation to the 2.5/187.5 on faces B and C, but on A where the grain was closer, it accentuates the weakness already disclosed by the 2.5/187.5 in relation to 10/3,000.

A second test had for its object the verification of the agreement of the tests with $\frac{1}{16}$-in. and $2\frac{1}{2}$-mm. balls by augmenting the number of impressions on a restricted area of the same casting. Table III shows that the figures are much more widely dispersed for the Rockwell apparatus, with the values being generally lower. These results have persuaded the Author to adopt the 2.5/187.5 combination be-

TABLE II.—*Hardness Results from Three Sides of a Casting as Tested by Three Systems.*

Side tested.	$\frac{1}{16}$-in./100	2.5/187.5	10/3,000
A.	156	167	174
B.	185	178	183
C.	190	193	Not done

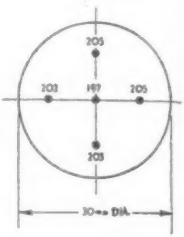

FIG. 3.—*Hardness-test positions on a* 30-*mm. tenon casting.*

cause they show the following advantages:—(1) they make possible the testing of thin or restricted areas of castings (2) they show reasonable dispersion (3) the cost of the apparatus is moderate and (4) quick testing and easy reading are possible.

This having been decided and carried into effect, efforts were made towards the esablishment of the relation between 2.5/187.5 and 10/3,000 combinations for hardness testing and the results of some comparisons are set out in what follows.

TABLE III.—*Tests Taken With the Rockwell Machine and* 2.5/187.5 *Brinell Over a Restricted Area.*

Face tested.	$\frac{1}{16}$-in./100.	2.5/187.5.
D.	166–169–180	190–190–193
E.	156–200–190	190–190–190

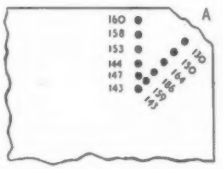

FIG. 4. — *Test positions on a scrap casting* (*full size*).

Example 1.—A 30-mm. ($1\frac{1}{8}$-in.) dia. tenon gave at its centre 10/3,000 hardness of 190, and the 2.5/187.5 set-up on four impressions surrounding that made by 10-mm. ball absolutely confirmed the 190 reading.

Example 2.—A foundry supplied a tenon showing a 10/3,000 hardness of 201 (laboratory tested). In another laboratory, four impressions made around the earlier one, using the 2.5/187.5 machine gave 198, 197, 202 and 203—an average of 200.

Example 3.—Three tests (Fig. 2) with the 10/3,000 set-up gave 210, 215 and 220, yielding an average of 215. Another laboratory using the 2.5/187.5 combination made ten tests parallel with the three impressions. The figures given were 208, 184, 212, 213, 227, 214, 215, 222, 215, 205, giving

an average of 211.5. If the lowest value of 184 be omitted, the results range between 205 and 227, a 22-point scatter as against the extremes 210 and 220 with the 10/3,000 tests.

Example 4.—This is of the same sort as example three. The three 10/3,000 hardness tests gave 226, 236 and 239—an average of 233.7 as against 241.1, the average of ten results from the 2.5/187.5 set-up; individual values for which read 238, 234, 239, 235, 238, 232, 270, 267, 232 and 226. The results 270 and 267 can be picked out as indicating the presence of small hard areas, probably mottled, as the 239 figure of the 10/3,000 would suggest. The other eight results are situated within 226 to 239 range which by chance unluckily in this case exactly corresponds with the extremes 226 and 239

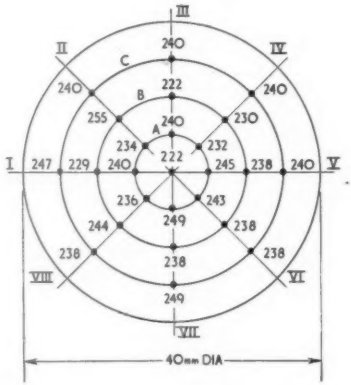

FIG. 5.—*Hardness values on a section of a* 40-*mm.* (1½-*in.*) *dia. bar of cast iron, using the* 2.5/187.5 *ratio of ball diameter to load.*

of the 10/3,000 test. This is a fortuitous coincidence, and is pointed out in order that it may not be too harshly interpreted.

Scatter of 2.5/187.5 Tests

Fig. 3 gives a picture of the hardnesses taken on a 30 mm. tenon and Fig. 4 (actual size) reveals the hardnesses yielded by a piece of scrap casting. The object sought was to provide figures for the change of hardness from the outside edge—said to be chilled. The casting was worn in service, consequent upon the fracture at A. The sequence of hardnesses from 160 to 143 gives good assurance of the values obtained from the 2.5/187.5 test, where one can be sure of the number 160, which is characteristic of the metal at 2 mm. ($\frac{5}{64}$ in.) from the edge of the casting, but it excludes the possibility that the chill placed in this area was efficient. On the other hand, the low hardnesses, 130 and 150 taken adjacent to the fracture at A, can explain the deterioration of the metal in this area. The abnormal figure of 186 is noteworthy, an anomaly sometimes encountered and one which confirms the necessity of taking three or four tests. Fig. 5 shows at double actual size the section of a 40-mm. (1½-in.) dia. bar of cast iron, with test impressions, using the 2.5/187.5 apparatus and the hardness numbers recorded. They are taken at the centre and radially on circumferences at ¼, ½ and ¾ of the radius. The numbers have been classified in the manner as set out in Table IV in order to conform to the Author's usual system of taking the average of five results, to include that of the centre, and the other four taken at the quarter or the half radius, on two diameters at right angles. In this case, the hardness at ¾ of the radius has also been taken for the purpose of record.

TABLE IV.—*Results Obtained from* 1½-*in. Bar as Detailed in Fig.* 5.

Taken on circumference.	Average of four tests, using the 2.5/187.5 combination, taken along the numbered diameters (Fig. 5).	
	Odd.	Even.
A.	243.5	236.2
B.	231.7	241.7
C.	244.0	239
General average ..	239.3	

(Without going into great detail, it can be pointed out that Table IV gives an idea of the magnitude of possible errors.)

Practical Applications of the 2.5/187.5 Test

The Author is convinced that conditions most favourable to the 2.5/187.5 test have been found to exist when, in grey cast iron, the hardness ranges from 190 to 220. The graphite holes are then scarcely of importance, whilst hard spots of free cementite are non-existent. For instance:

Where it is necessary to establish the quality of the liquid metal, one can cast a test-piece of suitable section to emulate the speed of cooling corresponding to the order of hardnesses.

When it is necessary to control the metal in the casting, for good quality a hardness of the order of 200 is required.

In both these cases, the 2.5-mm. ball is, under these conditions, the best. When the casting presents no other demands than that it shall machine easily, the inconvenience of the dispersion of the hardness presents only a minor drawback. As the presence of free cementite is not encountered in the large majority of iron castings it can be eliminated as a factor in scatter. If by mistake, cementite does turn up and escapes discovery by Brinell testing, then the whole of the section will be found to be affected, and in any case, the lowest hardnesses found will be of the order of 235 to 240.

Personal experience goes to prove that hardness control organized as set out above is efficient and allows the control of the chemical composition of cast irons—including the hyper-eutectic ones from 0.20 to 0.30 per cent. combined carbon to the hypo-eutectic type carrying up to 0.60 to 0.70 per cent. combined carbon. The Author emphasizes that he has only been able to indicate possibilities within a limited field, and therefore not universally applicable. The wise reader will verify the statements if he is interested and apply them to his own particular case.

British Blast Furnaces in the June Quarter, 1956

(These tables are published through the courtesy of the British Iron and Steel Federation.)

Derbyshire, Leicestershire, Notts, Northants, and Essex.

Name of firm.	In blast at end of the second quarter, 1956.					Weekly average in blast.	Total existing at end of quarter.
	Hematite.	Basic.	Foundry and forge.	Ferro-alloys.	Total.		
Clay Cross Co. (Iron & Foundries)	—	—	1	—	1	1	2
Ford Motor	—	—	1	—	1	1	1
Holwell Iron	—	2	1	—	3	3	4
Kettering Iron & Coal	—	1	1	—	2	1·8	2
New Cransley Iron & Steel	—	1	—	—	1	1	2
Renishaw Iron	—	—	2	—	2	2	2
Sheepbridge	—	1	1	—	2	1·2	2
Stanton Ironworks: Stanton-by-Dale	—	—	5	—	5	4·1	5
Staveley Iron & Chemical	—	—	4	—	4	4	4
Stewarts and Lloyds: Corby	—	3	—	—	3	3·8	4
Wellingboro' Iron	—	2	—	—	2	2	3
TOTAL	—	10	16	—	26	24.9	31
Lancashire (excl. N.-W. Coast), Denbighshire, Flintshire, and Cheshire.							
Brymbo Steel	—	1	—	—	1	1	1
Darwen & Mostyn	—	—	—	1	1	1	2
Lancashire Steel Corp'n.	—	2	—	1	3	3	3
Summers, J.	—	2	—	—	2	2	2
TOTAL	—	5	—	2	7	7	8
North-West Coast.							
Barrow Ironworks	3	—	—	—	3	3	4
Charcoal Iron	—	—	1	—	1	1	1
Millom & Askam	2	—	—	—	2	2	2
United Steel: Workington	2	—	—	1	3	3	3
TOTAL	7	—	1	1	9	9	10
Lincolnshire.							
Appleby-Frodingham	—	4	—	—	4	3.5	4
Lysaght's Scunthorpe Works	—	4	—	—	3	3	4
Thomas, R., & Baldwins: Redbourn	—	3	—	—	3	3	3
TOTAL	—	10	—	—	10	9.5	11
North-East Coast.							
Consett Iron	—	3	—	—	3	3	3
Dorman Long (Steel): Acklam	—	2	—	—	2	2	4
Redcar	—	2	—	—	2	2	2
Cleveland	—	2	—	—	2	2	4
Bessemer	—	2	—	1	3	3	3
South Bank	—	—	—	—	—	—	2
Gjers, Mills & Co.	2	—	—	—	2	2	5
Normanby Ironworks	2	—	—	—	2	2	3
Skinningrove Iron	—	1	—	—	1	1	3
South Durham Steel & Iron:							
West Hartlepool	—	2	—	—	2	2	2
Cargo Fleet	—	2	—	—	2	2	2
TOTAL	4	16	—	1	21	21	33
Scotland.							
Bairds & Scottish Steel: Gartsherrie	1	1	1	—	3	3	5
Carron	—	—	1	—	1	1	4
Colvilles: Clyde Works	—	3	—	—	3	3	3
Dixon's	—	2	—	—	2	2	6
TOTAL	1	6	2	—	9	9	18
South Wales and Monmouthshire.							
Briton Ferry Works	—	—	—	—	—	—	1
Guest Keen Iron & Steel: Cardiff	1	2	—	—	3	3	4
Thomas, R., & Baldwins: Ebbw Vale	—	3	—	—	3	3	3
Steel Company of Wales: Margam	—	3	—	—	3	3.8	4
TOTAL	1	8	—	—	9	9.8	12

Price Stabilization

Sir Anthony Eden has now wound up the series of talks with representatives of industry on the problem of checking increases in costs and prices. At three brief final meetings, representatives of the Trades Union Congress, private industry, and the nationalized industries were asked for their views and comments on a statement which the Government was intending to issue on its own responsibility, setting out the progress made in recent consultations and the problem still to be faced. The statement suggests for the first time that dividends should be limited as well as profit margins trimmed.

The Government statement points out that retail prices have been comparatively steady for the past two or three months, that there has been a substantial increase in exports in the first half of the year, and that there has been a considerable improvement in the balance of payments and in gold reserves. The statement stresses that this improvement is by no means sufficient and that there must be continuing effort to keep prices steady and as far as possible reduce them even where this process affects profits and dividends.

The Government reaffirms its intention to limit its own demands on the national income. The two points made by the Government were that the mounting severity of foreign competition rendered it more urgent than ever to break the cost spiral, and that our economic circumstances are now favourable to the maintenance of a period of steady progress if we avoid further increases in domestic costs.

Volta River Project

The Volta River project for hydro-electric development and aluminium production in the Gold Coast has been reported technically and economically practicable by the preparatory commission appointed in 1953, whose report with appendices has now been published. The project, the largest of its kind so far proposed for British African territories, envisages a dam across the Volta River, with a power station generating continuously about 600,000 kilowatts, most of which will go to supplying an aluminium smelting plant based on the Gold Coast bauxite deposits. It is proposed that the plant will ultimately produce 210,000 tons of aluminium a year, and use about 500,000 kilowatts of the Volta dam's electricity production. There are sufficient reserves of bauxite for more than 200 years.

The White Paper published in 1952 estimated the cost at £100,000,000 at the initial stage (to produce 80,000 tons of aluminium a year) and £144,000,000 by the final stage (210,000 tons). On prices ruling at September 30, 1955, the commission estimates the cost at £160,000,000 for the first stage and £230,000,000 at the final stage. These increases included the building of a higher dam than originally planned, to take advantage of an extra 10 per cent. of power now found to be available from the river Volta, and additional costs made clear by further investigation, as well as increases during four years in the cost of the necessary materials and equipment.

Two thirds of this cost is for the dam and power installation, smelting plant, and mines, which has still to be allocated among the British and Gold Coast governments and the aluminium companies concerned, Aluminium, Limited, of Canada, and the British Aluminium Company, Limited.

CATERPILLAR TRACTOR COMPANY, LIMITED, have purchased the factory, plant and stock-in-trade of the Birtley Company, Limited, County Durham. The latter company has, for the past nine years, been manufacturing earthmoving equipment under licence from the American parent of British Caterpillar, and this manufacture will be continued and expanded. Col. R. T. Edwards, managing director of the Birtley Company, will continue in charge as manager of the Caterpillar operations at Birtley and becomes a member of the board of directors of Caterpillar Tractor Company, Limited.

British Blast Furnaces in the June Quarter, 1956—*continued*

Staffordshire, Shropshire, Worcestershire, and Warwickshire.

Name of firm.	In blast at end of the second quarter, 1956.					Weekly average in blast.	Total existing at end of quarter.
	Hematite.	Basic.	Foundry and forge.	Ferro-alloys.	Total.		
Goldendale Iron	—	—	1	—	1	1	2
Lilleshall	—	—	1	—	1	1	2
Round Oak Steel Works	—	—	—	—	—	—	2
Shelton Iron, Steel & Coal	—	3	—	—	3	3	3
Stewarts and Lloyds: Bilston	—	2	—	—	2	2	3
TOTAL	—	5	2	—	7	7	12
Sheffield.							
Park Gate Iron & Steel	—	2	—	—	2	2	2
GRAND TOTAL	13	62	21	4	100	99.2	137

Weekly Average Number of Furnaces in Blast during the June Quarter, 1956, and the Previous Four Quarters

District.	1955.			1956.	
	June.	Sept.	Dec.	March.	June.
Derby, Leics., Notts., Northants, and Essex	26	24.9	25.5	25.7	24·9
Lancs. (excl. N.-W. Coast), Denbigh, Flint, and Ches.	5.8	6.4	6.7	7	7
Lincolnshire	10	10	10	10.1	9.5
North-East Coast	22	22	20.8	21	21
Scotland	9	9	9	9	9
Staffs., Shrops., Worcs., and Warwicks.	7	7	7.2	7	7
S. Wales and Monmouth	9.2	9.6	9.8	10.8	9.8
Sheffield	1.2	1.3	2	2	2
North-West Coast	7.7	7.8	9	9	9
TOTAL	97.9	98	100	101.6	99.2

The following companies have furnaces in course of construction or rebuilding:—Dorman Long (Steel) (2); Lancashire Steel Corporation; South Durham Steel & Iron (West Hartlepool and Cargo Fleet); Millom & Askam Hematite Iron; Colvilles.

Rise in US Steel Price

"Persistently rising costs with which the company is confronted" are reflected in the United States Steel Corporation's decision to raise its price by an average of $8.50 (about 61s.) a ton for carbon and alloy steel. The increase, which came into effect on August 7, amounts to about 6.25 per cent. on the prevailing prices for steel products. Similar action has been taken by the Republic Steel Corporation and the other producers are expected to follow suit.

United States Steel, in its statement announcing its decision, said that the costs which have prompted it included "the initial prior employment costs resulting from the new labour agreement that has just been concluded with the United Steelworkers." The new wages contracts were signed at the weekend and all 12 major producers have signed identical agreements. More and more men are returning to work as plants are getting under way again, although it will still be some time before full operations are resumed.

Currently, for example, the American Iron and Steel Institute estimates that operations at US steel mills are at 52.4 per cent. of rated capacity, with production at 1,290,000 tons. This compares with recent figures of 16.9 per cent. and 415,000 tons, and with 89.4 per cent. and 2,157,000 tons in the corresponding period of last year. Ingot production last week was placed at 80.3 per cent. of capacity.

Company News

BORAX (HOLDINGS), LIMITED—The directors have declared an interim dividend on the deferred ordinary stock of 6 per cent., less tax to be paid, on September 14, 1956, for the year ending September 30, 1956, against a 5 per cent. interim last year.

A. & J. MAIN & COMPANY, LIMITED, structural engineers, etc., of Glasgow—A dividend of 10 per cent., less tax, is recommended for 1955. This compares with 7½ per cent. for 1954 when, however, holders also received a tax-free bonus of 8½ per cent.

METAL INDUSTRIES, LIMITED—As forecast in their interim statement in January, the directors are not recommending a dividend on the £3,900,000 ordinary capital for the year ended March 31, 1956, compared with 9 per cent. for each of the two preceding years. Subject to audit, the group has incurred a loss of £544,923 before tax, against a profit of £631,445.

J. SAMUEL WHITE & COMPANY, LIMITED, ship and boat builders, of Cowes (I.o.W.)—The company has purchased the £18,000 share capital of Henry Bannister & Company, Limited, ropemakers, of Cowes, for cash on a par basis. The present directors have resigned and the new directors are as follow:—Mr. J. A. Milne, Lord Glyn of Farnborough, Sir Charles Lillicrap, and Mr. R. Allen.

W. H. DORMAN & COMPANY, LIMITED, manufacturing engineers, of Stafford—The directors state that if a proposed scrip issue of five non-voting "A" ordinary shares for every two ordinary shares held is approved, the dividend on the increased capital will be 3d. per share, thereby giving each shareholder the same cash dividend on his new total holding as he would have received on his original holding.

MANN, EGERTON & COMPANY, LIMITED, electrical and motor engineers, etc., of Norwich—The issue of 710,721 5s. ordinary shares at par has been taken up on provisional allotment letters to the extent of 699,031 shares (or 98.3 per cent.). Applications for the balance of 11,690 shares were received for a total of 159,631 shares. Allotments in respect of applications up to 50 shares have been met in full, but other applications have been heavily curtailed.

FOUNDRY EQUIPMENT, LIMITED—A record unexecuted order-book and level of turnover at the end of the financial year to March 31, 1956, are reported by Mr. Austin S. Beech, chairman, in his statement accompanying the report and accounts. A large proportion of the unexecuted orders is for oversea markets. Ever-rising costs, due to reasons outside the company's control, are building up fierce competition in export markets, he declares, and adds: "We may be compelled to carry a considerable proportion of the increasing costs which industry generally is being forced to bear in order to maintain its footing in world markets."

UNITED GAS INDUSTRIES, LIMITED—The group increased its earnings in the year to March 31 last—due partly to a larger turnover and partly from the diversified interests. All group companies have spent substantially on buildings and plant improvements but profits have not yet reflected the full benefit. The strain on finances, also overdraft repayment, was met by an issue of £600,000 6 per cent. unsecured loan stock. The June, 1956, quarter's trading has been satisfactory but "the profit margin is narrow and sensitive to any reduction in turnover," says the chairman, Lt.-Col. W. Cabourn Smith. Group profit of £648,114 compared with £548,056.

New Patents

(Copies of complete specifications are obtainable from the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2, price 3s.)

751,233. Gebr. Bohler, 14, Elisabethstrasse, Vienna 1, Austria.

Equipment for the casting, especially the continuous casting, of high-melting-point metals. The molten metal in the solidifying zone is surrounded by an electrical coil. Several packets of laminated iron sheets are arranged around the coil, the middle sheet of each packet being in an approximate perpendicular plane to a tangent drawn to the circumference of the cross section of the billet at the point nearest the middle sheet.

751,369. General Electric Company, Schenactady, NY, USA.

Magnetic material, particularly cast-alloy magnets, consisting of iron alloyed with 0.8 to 6.2 per cent. by weight of aluminium based on the weight of the total alloy, and having a high permeability with varying specific resistance and very low hysteresis loss.

751,105. Hydrocarbon Research Inc., 115, Broadway, New York, 6, N.Y., USA.

The reduction of iron oxides in finely divided form by intimate contact and reaction with hydrogen. Both the process itself and the apparatus required are described.

751,379. General Motors Corporation, Grand Boulevard, Detroit, Michigan, USA.

A core assembly for casting a V-type internal combustion engine block. It comprises a sand core having a number of angularly-disposed pairs of cylinder defining portions, and water-jacket sand cores having for each cylinder-defining portion a bore portion of such diameter as to be slidable over the cylinder to a position in which there is an annular space between the bore portion and the cylinder-defining portion. The core and mould assembly is also described, together with the method of casting.

751,411. Vereingte Osteriichische Eisen und Stahlwerke, A.G., Muldenstrasse, 5, Linz a. Donau, Upper Austria.

An improved process for blowing pig-iron that contains less than 0.5 per cent. silicon, using oxygen or oxygen-enriched air in the blast. More specifically, the invention is concerned with the removal of phosphorus from such pig-iron and in particular with the making of steel containing less than 0.050 per cent. phosphorus.

751,472. Titan Co. A/S, Fredrikstad, Norway.

The production of low-carbon iron. Iron oxides are heated with an excess of solid carbonaceous material in a rotary furnace without melting. Pure or concentrated iron oxides in agglomerated form without reducing agent are, in this process, fed into the furnace together with the finely divided carbonaceous material, which is partly burnt during the reaction of the iron oxides. The ashes and excess of carbonaceous material are subsequently removed.

751,534. M. G. Whitfield, 2, Harvard Street, Garden City, New York, USA.

A light-metal piston provided with a piston-ring groove or grooves. Embedded therein is a heavy metal reinforcement which is of greater length than width. The groove or grooves are cut in that part of the piston having the reinforcement so that the walls of the groove have hard-wearing surfaces. The reinforcement of strand-like heavy metal, such as ferrous drawn wire, is supported in the mould, but not in contact with the mould wall. The light metal is then cast in the mould so as to embed the reinforcement.

Shell Moulding as an Aid to Rapid Machining*

By W. G. Patton

Shell moulding has grown by leaps and bounds. But when the latest techniques are combined with a new composition of metal, all sorts of possibilities are opened for casting products which previously were difficult and costly to forge and machine.

The Central Foundry Division of General Motors, (USA) proves the point. In casting crankshafts for the Pontiac Motor Division, it turns out a better product at lower cost. Big savings in machining time and material are thrown in as a bonus.

Two "firsts" stem from this development. It is the first use of ArmaSteel (containing microscopic additions of bismuth and boron) for a precision cast crankshaft. It is also the first use of a cast crankshaft in a GM car. Now that the desirable properties of this material have been determined, and the casting method and cost figures worked out, it is likely that new uses for shell moulding will be sought.

Competitive with Forging

No cost figures were revealed at Danville, Ill., recently where the process was shown publicly for the first time. However, there was no doubt that crankshafts in the new material are strongly competitive with forged crankshafts, and that the process offers advantages in design, amount and ease of machining, and tool life.

Reports by the foundry industry insist that savings in production costs may equal 10 to 15 per cent. of the previous cost of the finished part. Substantial weight is saved by going to the cast crankshaft. Gross weight of a forged Pontiac V-8 crankshaft for the present engine is 76 lb. Machining removes 18 lb of steel, bringing the finished weight to 58 lb.

Using ArmaSteel, as-cast weight is only 64 lb. Only 10 lb. of metal is removed during machining, bringing the finished weight to 54 lb. Thus, less metal is removed during machining, machinability of the part is improved, and the weight of the part is reduced 4 lb. Moreover, Pontiac engineers claim that the cast crankshaft is superior in many respects to its forged counterpart.

The remarkable growth of shell-moulded products produced by the Central Foundry Division is reflected in the following figures:—

	Shell-moulded Products (Short tons)
1951	3
1952	650
1953	3,700
1954	6,500
1955	20,500
1956	Over 100,000

The research story behind the development of the material begins early in the 1920s, when A. L. Boegehold, assistant to the director, GM research, started work on the problem of shortening the annealing cycle for malleable iron. At the time work was started, the annealing cycle required more than 100 hours. Changes in composition, plus the development of better furnace equipment with atmosphere control, reduced the cycle to 32 hours. Later, this was further reduced.

Boegehold holds several patents on short-cycle malleable iron, including a patent covering bismuth additions granted in 1942. Both the Crane Company and General Motors hold patents on the use of bismuth and boron in malleable iron.

Outstanding Advantages

Bismuth content of ArmaSteel used in crankshafts is 0.02 per cent. Boron content is 0.003 per cent. The bismuth and boron additions are necessary in a large section like a crankshaft to produce the desired distribution of pearlite when the material is annealed.

The advantages of the new, precision-cast crankshafts may be summarized as follows:—

(1) Unlimited supply of non-critical material.
(2) Less stock removed by machining.
(3) Several machining operations, including cheeking, are eliminated.
(4) Wider latitude for crankshaft design.
(5) Good dimensional control.
(6) Improved machinability and better tool life.
(7) Lower overall cost.

Actually lower overall costs may be due as much to gains in manufacturing efficiency as to improvement in processing. Many competent observers believe the Danville foundry operation is probably among the most efficient, high-production shell-moulding operation in the country to-day.

Shell moulding of crankshafts by the Central Foundry Division is distinctive in several ways:—

(1) This is the only automotive crankshaft being produced of ArmaSteel; other producers of cast crankshafts use nodular iron.
(2) GM has eliminated the use of shot for backing the moulds. The moulds used are approximately twice as thick ($\frac{1}{4}$ in.) as conventional shell moulds for this application. Efforts being made to reduce this are promising. In addition, loose, unbonded sand is added underneath and on top of the moulds.
(3) Sutter moulding machines with built-in electric heating units are used. Pattern life has been excellent.
(4) A wax-type parting solution is employed.
(5) Two castings are poured in a horizontal position. (Firms using shot backup generally pour crankshafts vertically.)
(6) The two moulds are joined by gluing.

In addition, there are other features of the Danville operation that are either unique or are not

* Condensed from an article printed in *Iron Age* entitled "Speedy Shell Moulding Saves Machining Time."

Shell Moulding as an Aid to Rapid Machining

widely used in US foundries to-day. The shakeout is 100 per cent. mechanized. An operator, seated at a console, controls all shakeout operations. Gates and risers are removed by swinging a heavy pendulum. Castings are Brinelled 100 per cent. without manual handling, while the equipment is fully automatic. There is also 100 per cent. Magnaglow and 100 per cent. resonance inspection.

Probably the outstanding contribution to the efficiency of the entire operation is the substitution of mechanical equipment for practically every manually handled job in the entire foundry. The cleanliness and housekeeping of the Danville foundry is outstanding.

The first sample crankshaft in the new material was put on test in February, 1953. A total of 24 was furnished to Pontiac Motor Division in November, 1954. By August, 1955, Pontiac was using 25 per cent. cast crankshafts. Early in November this was increased to 75 per cent. and now 100 per cent. is being used.

Machinability of the crankshafts is rated 33 per cent. better than SAE 1045. The tensile strength is in the range of steel: that is, 45 tons per sq. in. The elongation associated with this is approximately 2 per cent.

According to Pontiac, rack-to-rack lathe cycle time on in-line diameters has been cut in half. For some machining operations, the life of high speed tools has been quadrupled. Life of some carbide tools has been extended ten times.

Double-thick shells used

Mixed shell material is transferred in a closed conveyor to the shell making machines. The Sutter machines have an automatic cycle. Electric heat is used for the patterns. After dumping the sand-resin mix over the heated patterns, the shell is cured with gas heat. The completed half shell is then stripped from the pattern. The cope and drag shell-moulds are produced side by side, then transferred for assembly.

Resin glue is vibrated on to the outer margin of the cope shell in a series of spots. The cope is then placed on the drag and squeezed. The heat in the shell helps to produce a very strong bond. Clamps are not required.

The shells are then transferred to a conveyor that is synchronized with a moulding conveyor. Each shell is bedded in loose sand. It is then covered with additional sand. The sand additions provide backing in much the same way as shot is used in other shell-moulding operations, except that handling of sand is easier.

Boron is added with the charge as a 5 per cent. boron, ferro-silicon alloy. Bismuth is added to the ladle just before pouring the castings.

The shakeout operation is performed mechanically on equipment developed by the Danville plant. The operation is completely automatic. After 30 min., the castings are debobbed mechanically. They are then transferred to the annealing department for initial cleaning and inspection.

To minimize warpage during the 21 hr. annealing cycle at 955 deg. C., castings are placed in individual alloy cradles. The packed cradles are placed on a 3-tray carrier for transfer to the kilns. The carrier moves automatically to a predetermined station. Castings are air quenched from 900 deg. C., then reheated to 650 deg. C. and tempered to 217 to 269 Brinell hardness.

Shafts Sonically Tested

The next operation is hot straightening in a press which rolls the crankshaft 90 deg. in the fixture, presses the shaft again and then ejects it. They are then taken outside by conveyor for cooling. The conveyor has automatic pickup hooks.

The cooling conveyor unloads automatically at the Brinell fixture. The fixture indexes, positioning the crankshaft under the automatic grinder. After grinding, the machine indexes to the Brinell machine. If the proper hardness range is maintained, the crankshaft is sprinkled with a dye. If the hardness is out of range, the dye is not applied. The unloading from the machine is fully automatic.

Following end milling and centre-drilling operations, crankshafts undergo Magnaglo inspection. The crankshaft is then lowered into a sonic test chamber. A hammer trips at the base, ringing the crankshaft. The tone is measured electronically. If the tone is within the specified range, a dye is sprayed on the crankshaft. Periodic soundness tests of crankshafts are also made, using Cobalt 60.

An advantage of shell-moulded crankshafts that is hard to evaluate is ability to produce crankshafts that could not be readily forged.

Changes of Name

Among the companies which have recently changed their names are those listed below. The new titles are given in parentheses.

ROSCO CONVEYOR COMPANY, LIMITED, Kenyon Street, Blackburn, Lancs (Charlson Bros., Limited).

BORAX CONSOLIDATED (SALES), LIMITED, Carlisle Place, London, S.W.1 (Borax Consolidated, Limited).

FARRINGDON METALLIC FINISHERS, LIMITED, Stoney Lane, London, E.1 (Pepe (London), Limited).

HOUGHTON ENGINEERS, LIMITED, Trading Estate, Fence Houses (Bursgreen (Durham), Limited).

SAGAR BURSGREEN, LIMITED, machinery factors, etc., of Water Lane, Halifax (Bursgreen Sales, Limited).

CINEMAKER COMPANY, LIMITED, Egerton Street, Nottingham (Hanmade Conveyor Equipments, Limited).

AVIS & BAGGS, LIMITED, electrical engineers, etc., of 140/141, Friar Street, Reading, Berks (Andec, Limited).

Recent Wills

WRIGHT, A. F. M., formerly a representative for the Butterley Company, Limited £11,653

CLARK, DR. A. B., industrial medical officer of the David Brown group of companies since 1940 ... £19,261

PARSONS, G. L., chairman of the Parsons Marine Steam Turbine Company, Limited, Wallsend-on-Tyne £148,766

WHARTON, HARRY, president and founder of the Wharton Crane & Hoist Company, Limited, Reddish, Stockport £63,053

LEVISON, WALTER, chairman of High Grade Castings, Limited, Leighton Buzzard, and a director of Richards Bros. & Sons, Limited, hand-tool manufacturers, of Sheffield, and other companies ... £32,475

PRESSED STEEL COMPANY, LIMITED—Col. F. T. Davies has been appointed to the board.

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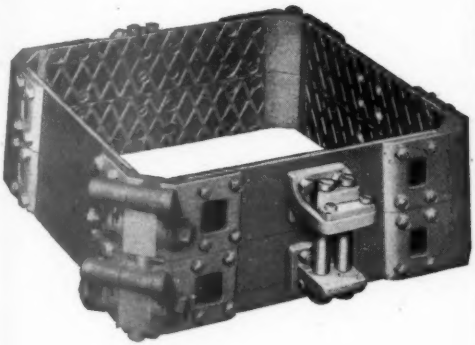

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Personal

Mr. JOSEPH TAYLOR, a director of the Borough Foundry, Lye, near Stourbridge, with his wife celebrated their golden wedding on August 7.

The secretary of Cammell Laird & Company (Shipbuilders & Engineers), Limited, Mr. E. M. LLOYD has retired and has been succeeded by Mr. N. F. CAVE.

Mr. C. K. CURTIS, home sales manager of the Eagle Engineering Company, Limited, Warwick, has been appointed sales manager in succession to the late Mr. B. Hackett.

Mr. J. L. WARNOCK is to resign from the board of Hills (West Bromwich), Limited, on December 31. He will be succeeded as financial director by Mr. R. G. Chadwick, the secretary.

Mr. F. J. BACKLOG has been appointed secretary of Oakley Brothers, Limited, Cradley Heath, Staffs., as from August 1, in succession to the late Mr. F. G. Wilmot, who died in June last.

Rhodesian Selection Trust Group of Companies announce that Mr. R. N. HARLE has been appointed assistant consulting mining engineer. He will take up his new duties on January 1, 1957, at Kalulushi.

Caterpillar Tractor Company, Limited, announce that Mr. DENIS H. GULLIVER has been appointed secretary of the company, and Mr. GRAHAM W. ALMROTT becomes manager of the company's operations at Desford, Leicester.

NORTON GRINDING WHEEL COMPANY, LIMITED, announces that Mr. Alfred E. West and Mr. John B. Morrison have been appointed directors of the company. Mr. West is the firm's chief accountant and Mr. Morrison, general works manager.

Mr. J. COOPER, chairman and managing director of Sanbra, Limited, manufacturers of plumbers' brassfoundry, Birmingham, was one of ten recipients of a gold watch for the completion of 25 years' service with the Sanbra Group. Thirty-three employees have now completed 25 years' service.

KEITH BLACKMAN, LIMITED, announce that the following executives have been appointed to serve as directors from August 1:—Mr. C. J. ATKINS, sales director; Mr. F. W. GOODGE, contracts director, and Mr. S. HUDSON, director and London works manager. Simultaneously, Mr. A. H. WOODLEY was appointed sales manager.

The new chairman of the British Institute of Management is Mr. H. WILMOT, C.B.E., chairman and managing director of Beyer, Peacock & Company, Limited. Mr. Wilmot succeeds Mr. H. F. SPENCER, who retires after the customary period of two years. In recognition of his services Mr. Spencer has been elected a life vice-president of the Institute.

Mr. C. F. MORGAN, former managing director of Bath Foundries, Limited, until his retirement in 1949, and Mrs. Morgan, celebrated their golden wedding recently. Mr. Morgan has spent his working life in the foundry trade, first at Stothert & Pitt, Limited, Bath, for 21 years, then as a partner in the Longmead Foundry and afterwards at Bath Foundries, of which he is still a director.

Mr. DEREK MORRIS, A.R.S.M., B.SC., who graduated this July with first-class honours in metallurgy at the Royal School of Mines, has been awarded the Bessemer prize and medal and also the Charles Salter prize by the Governing Body of the Imperial College of Science and Technology. Mr. Morris has recently joined A.P.V.-Paramount, Limited, the stainless steel and non-ferrous founders of Crawley, Sussex.

Mr. F. THOMAS, general manager of the Redbourn steelworks of Richard Thomas and Baldwins, Limited, Scunthorpe, has been elected president of the Lincolnshire Iron and Steel Institute in succession to Lieutenant-Commander G. W. Wells. Mr. CHARLES WARBURTON, secretary of the Institute since 1938, has resigned the office through ill-health, and is succeeded by Commander IAN STEEL, public relations officer at the Appleby-Frodingham works.

Bonnington Castings, Limited, May Move Plant

Bonnington Castings, Limited, the Leith firm against whom complaints were made by local residents, because of the noise from their works at night, may move part of their works to Broxburn, West Lothian, in the near future—but work will continue at Primrose Works, Leith. A spokesman for the firm stated at the week-end: "Negotiations are taking place regarding our moving to Broxburn, but there is nothing signed or sealed so far." He added that if the premises at Broxburn, which are owned by Scottish Oils, Limited, were purchased, they would be used to house an extension of the firm's dressing shop. It was the steel-castings dressing shop operations which caused complaints about noise. An acoustics expert recently visited the Leith works, and his report stated that there had been "quite a fair diminishment in the volume of noise." The firm installed a new silencer earlier in the year.

The premises the Bonnington company are negotiating for are the candle works on the banks of the Union Canal at Broxburn which Scottish Oils closed down a week or so earlier. A few weeks ago Bonnington Castings announced that they had purchased premises on the Sighthill Industrial Estate, Edinburgh. It was intended that the dressing shop extension should be moved to these premises, but plans for this were subsequently abandoned, and the premises have now been purchased by another firm.

Obituary

Mr. E. BRYCE FULTON, formerly financial director of the David Brown Group, Huddersfield, has died in Glasgow. He retired last year, having joined the company as financial and cost comptroller. Previously he had held positions with the Steel Company of Scotland, Limited, and Fullerton, Hodgart & Barclay, Limited, Paisley.

Mr. WILLIAM JOHNSTON WINNING, died suddenly in Kilmarnock Infirmary at the age of 58. An employee of Glenfield & Kennedy Limited, since 1914 he had been for the last eight years, chief hydraulic inspector in the test shop. In 1953, Mr. Winning was presented with a gift from the firm on his completion of 40 years' continuous service in their employment.

THE BRITISH MALLEABLE TUBE FITTINGS ASSOCIATION announces that all its members, representing the great majority of British manufacturers of malleable tube fittings, have re-affirmed the policy which they decided upon earlier in the year, by which they will not increase their prices during the remainder of 1956, unless forced to do so by appreciable increases in such production costs as are completely outside their control.

From the **FOSECO** *Casebook*

"I'm really NEEDLED" said our client

. . . and he certainly needed something to break down the needle-like structure of aluminium alloys containing 9-13 % silicon, in order to increase their mechanical properties.

We can't quite recall whether we introduced **NAVAC** *to our client, or our client to* **NAVAC.** *Either way, the remedy was extremely effective.*

RX *The remedy* = FOSECO **NAVAC**

a vacuum processed metallic sodium, sealed in air-tight containers and thus free from oil, oxides and other gas-producing elements that otherwise lead to porous castings.

NAVAC is the latest and finest **FOSECO** achievement! It meets a long-felt want by eliminating crucible attack, and is less expensive to use than modifying salts. It is clean and safe to handle—there is no risk of **NAVAC** picking up moisture.

Modification is quick and easy to carry out as gas pick-up is eliminated. **AND** more control is possible as **FOSECO NAVAC** is packed in accurately weighed units:

Foseco **NAVAC** No. 25 to treat 50 lb. melts (25 kg.).
Foseco **NAVAC** No. 50 to treat 100 lb. melts (50 kg.).
Foseco **NAVAC** No. 75 to treat 150 lb. melts (75 kg.).
Foseco **NAVAC** No. 100 to treat 200 lb. melts (100 kg.).

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News in Brief

F. E. WEATHERILL, LIMITED, of Tewin Road, Welwyn Garden City, announce that the British Transport Commission have just placed an order with them for 13 Epping auto-shunters for British Railways.

THE Non-destructive Testing Group of the Institute of Physics is holding a symposium on "X-ray Microscopy and Microradiography" at the Cavendish Laboratory, Cambridge, from August 16 to 21.

BRITISH TRANSPORT COMMISSION are to use an electronic computer to calculate distances between all stations and depots on British Railways. Distance is obviously a major factor in transport cost and it is usually coupled with weight in fixing scales of charges for the carriage of freight.

A THREE-DAY Convention on Materials Handling is being organized by the Materials Handling Sub-committee of the Institution of Production Engineers, and will take place at Leamington Spa, Warwickshire, from September 27 to 29. Details are available from the Institution's headquarters, 10, Chesterfield Street, London, W.1.

THE Central Electricity Authority's course for apprentices is to be held at the Birmingham and District Industrial Safety Training Centre, Summer Road, Acocks Green, Birmingham, 27, on August 20 to 22 and August 27 to 29. Those wishing to attend should send their applications to Mr. W. G. Appleyard, 21, Steelhouse Lane, Birmingham, 4.

"MANAGEMENT—PROFITS—LIVING STANDARDS" has been chosen as the theme of a national conference to be held this year at Harrogate from October 31 to November 2, organized by the British Institute of Management. The conference will be opened by Dr. The Rt. Hon. Charles Hill, P.C., M.P., Postmaster-General, on the evening of October 31.

DALLOW LAMBERT & COMPANY, LIMITED, announce that expansion of the company's business has necessitated the acquisition of improved accommodation for their London office and new premises have been taken at 6, Stratton Street, London, W.1 (telephone: GROsvenor 4766). A small permanent exhibition of dust-control equipment is to be installed.

A SCHEME to improve the River Lee Navigation between Enfield Lock and its junctions with the River Thames, at a cost of £864,000, was announced last week by Sir Reginald Kerr, general manager of the British Transport Commission's Waterways Division. It is the largest project yet to be announced in connection with the Commission's £5¼ millions development plan covering their principal inland waterways.

A CALL for tenders has been received through the Export Services branch of the Board of Trade, from the Chief Controller of Purchase, Hindustan Steel (Private), Limited, 2, Fairlie Place, Calcutta, for the design, supply and erection of a grey-iron foundry. Tender documents (price Rs. 250, not refundable) may be purchased from the office of the firm; the reference number is HSLP/E. IV-1233, and the closing date September 20.

SHEEPBRIDGE ENGINEERING, LIMITED, announce that agreement has been entered into with Gebr. Eickhoff Maschinenfabrik u. Eisengiesserei, m.b.H., Bochum, Germany, for the manufacture at the Chesterfield works of Sheepbridge Equipment, Limited, of components for Eickhoff steel-plate mining conveyors. Sales of the conveyors will be handled by W. Stanley Jones (Engineers), Limited, of Altrincham, Cheshire, and E. Wheatley, Limited, of Sheffield, as at present.

THE FIRST of a new-style long-service award ceremony was held at Witton, Birmingham, recently when when 74 recipients from I.C.I., Limited, were guests of honour. Mr. T. G. Austin, personnel director, was in the chair. He said that the decision to revise the type of assembly and to keep each function on a small scale, had been made so that invitations could be extended to wives or husbands of long-service employees. The event took the form of an assembly in a comfortable lounge, a dinner—and gifts of flowers for all ladies present.

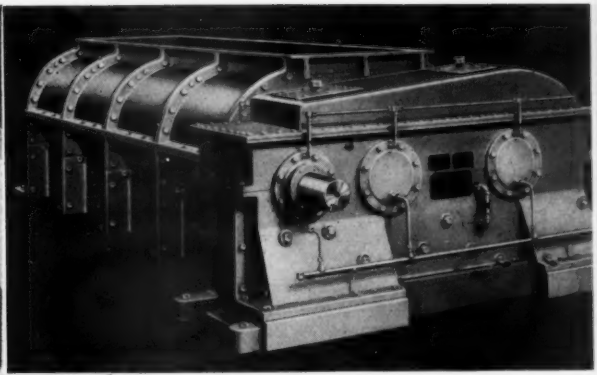
THE IRON AND STEEL INSTITUTE announce that by invitation of the Steel Company of Wales, Limited, the thirty-first meeting of the Iron and Steel Engineers' Group will be held in South Wales on October 4 and 5. The meeting will be devoted to the presentation and discussion of two papers and to visiting the Margam and Abbey Works of the Steel Company of Wales, Limited. As the maximum number of members that can be accommodated on the works visits is 250, members who wish to attend should apply as soon as possible to the secretary of the Institute, Mr. K. Headlam-Morley, 4, Grosvenor Gardens, London, S.W.1.

A ONE-DAY CONFERENCE entitled "Rubber in Engineering," organized by the Natural Rubber Development Board, will take place on September 27 at the Institution of Electrical Engineers, Savoy Place, London, W.C.2. The main purpose of the conference will be to discuss five technical papers circulated beforehand and the programme also includes the first showing of the Board's new half-hour film "Rubber in Engineering." A few places are still available at the conference, which is restricted to qualified engineers. Application should be made to the conference secretary, the Natural Rubber Development Board, Market Buildings, Mark Lane, London, E.C.3.

FREE BOOKLETS dealing with a wide variety of topical subjects are being made available to employees of Richard Thomas & Baldwins, Limited, at Ebbw Vale, as part of an educational experiment. Nine different titles—a total of 2,880 books—have been distributed at fortnightly intervals during the past six months. Among the first 12 titles of booklets in the course of being published and distributed are "The Atom," "Who Are You?," "What are the Facts about Your Incomes?," "Home is What You Make it," "What Makes a Team," "Why Garden?," "What are the facts about our taxes?," "I've Gotta Horse," "Space Satellites can help," "Why does Crime thrill?," "What is Automation?," and "The Pools."

THE MAIN EXHIBIT on Northern Aluminium Company's stand (No. 136) in the indoor exhibition at the Society of British Aircraft Constructors display at Farnborough (September 3 to 9) will be a 6-ft. long model of a 4,000-ton plate stretcher that is to be installed in the company's Rogerstone works early next year. The stretcher, which is being constructed by the Loewy Engineering Company, Limited, is claimed to be the biggest in the United Kingdom for stretching aluminium plate and will be used primarily for aircraft material. Hydraulically operated at 2 tons per sq. in., and fully automatic from the time the plate is put on to the receiving apron, it will stretch to a maximum length of 50 ft. and will take plate up to 10-ft. wide and 6-in. thick. The primary advantage offered by stretched plate is freedom from residual stress and therefore from distortion on machining. Other exhibits include Noral sections, castings and forgings, and there is a display of illuminated photographs in full colour showing the various methods of fabrication in Northern Aluminium Company's works.

Batch and Continuous Sand Mixers



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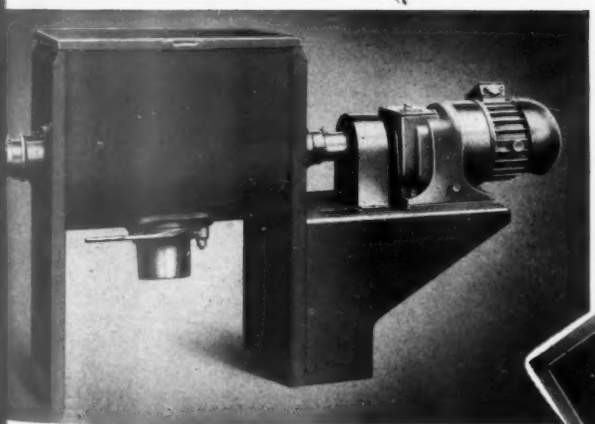

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Engineers
ESTWOOD WORKS – PETERBOROUGH

Raw Material Markets

Iron and Steel

Many ironfoundries resumed work on Monday following the annual holidays. Most of them had adequate supplies of raw materials on hand to enable them to restart promptly and, with repairs to plant and cupolas completed during the holiday period, production of castings should continue without interruption. The volume of business on hand varies appreciably in the different sections of the industry. Demands for high-duty castings are heaviest from the engineering and speciality foundries supplying the machine-tool, heavy electrical and power plant, and agricultural implement makers, and steelworks, collieries, etc. These foundries have full order-books. Their outputs are assisted by improved deliveries of pig-iron in the low-phosphorus and hematite grades. Although the engineering foundries connected with the motor-vehicle trade are absorbing fair tonnages of low-phosphorus iron and hematite, their demands remain on a reduced scale. There is also a reduced demand for refined iron; this has enabled some producers to send tonnages abroad. The furnaces producing low-phosphorus iron and hematite are returning good outputs and generally are able to dispose of them without much difficulty.

Business at the light foundries shows little change, some of them being much better employed than others. The demand for builders' castings is below normal, while the credit squeeze hinders any possible improvement in the domestic utensil trades. Production of high-phosphorus iron is at about recent levels, although the need for improved supplies of basic steelmaking pig-iron results in erratic outputs of the foundry grades. Supplies appear to satisfy consumption, but there is little to spare and some orders are behind schedule.

All the foundries are fairly well off for scrap, holidays and reduced consumption by some units having eased the demand. Arisings of heavy cast-iron scrap and machinery metal are readily accepted. Deliveries of foundry coke cover consumption, while no difficulty is experienced in obtaining ganister, limestone, and firebricks.

Non-ferrous Metals

After being extremely firm on both sides of the Atlantic last week, copper is now quietly steady. The feature of the market is that the United States Customs smelter price has now moved up to within ¼ cent of the domestic producers' price of 40 cents a pound. The Suez Canal trouble continues to be a major factor influencing prices and the lower quotation on Monday reflected the feeling that, while the settlement of the affair may be lengthy, there now seems little likelihood that the situation will develop into a shooting war. That being so, attention is focused on the continuing labour disturbances in Rhodesia, where copper mines are experiencing a series of short strikes. In fact, when the African mineworkers walked out at Mufulira on Monday it was the fifth mine to be so affected. Presumably, strikes can be expected to occur at Nchanga, Kansanshi, and Chibuluma over the next week or so as these are the only three mines which have so far been free of these lightning strikes which have been called as a protest against the companies automatically transferring certain African miners to monthly contracts. Generally speaking, London is setting the tone and the improvement in the Customs smelters' price has been the result of the higher levels recorded on the LME, together with improved buying from the Continent.

Although the tin market is contending with the threat of an industry-wide strike in Malaya on Tuesday, and the possible dislocation of supplies as a result of developments at the Suez Canal, the price has remained remarkably steady. The tin market has for some months shown a strong inclination to ease at the slightest provocation. But if, in addition to continued tension in the Middle East, strike threats in Malaya and possibly in Nigeria, and an expanded demand from tinplate manufacturers when the US steel mills get back into full operation, the market does not respond sharply it will be surprising.

Demand for lead is strong on both sides of the Atlantic and the price is firm in America at 16 cents a pound New York. Storage battery makers are absorbing large tonnages and demand is also expanding from cable makers, pipe and sheet makers, and those companies producing caulking materials and solders. Should the automobile industry revive it is possible that the price may go higher if the demand is sustained for any length of time. One important bullish factor affecting both lead and zinc is the announcement that the US Government intends to resume its purchases of foreign lead and zinc in exchange for farm surpluses. Two new restrictions may, however, lessen the amount of the metals offered: the metals must be processed and smeltered at foreign plants and delivery will have to be made within 60 days from the date of contract.

The price of zinc is holding up well, but the undertone is not strong. The US market is still awaiting a revival of demand from galvanizers following the end of the steel strike.

Following a rise of 1 cent per pound in the Canadian price, the basic price of aluminium in the United Kingdom was raised on Tuesday by £8 a ton to £197. The basic price has been subject to a surcharge of 30s. a ton since July 1 to cover the higher cost of non-Canadian metal purchased for the UK market, so that the current price is £198 10s.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* August 9, £318 10s. to £319; August 10, £312 to £313; August 13, £312 to £312 10s.; August 14, £302 10s. to £303; August 15, £304 10s. to £305 10s.

Three Months: August 9, £317 10s. to £318; August 10, £312 to £312 10s.; August 13, £311 to £312; August 14, £302 10s. to £303; August 15, £304 to £305.

TIN, Standard—*Cash:* August 9, £773 to £775; August 10, £770 to £771; August 13, £775 to £776; August 14, £768 to £769; August 15, £773 to £775.

Three Months: August 9, 770 to £771; August 10, £766 to £767; August 13, £771 to £772; August 14, £765 to £766; August 15, £770 to £771.

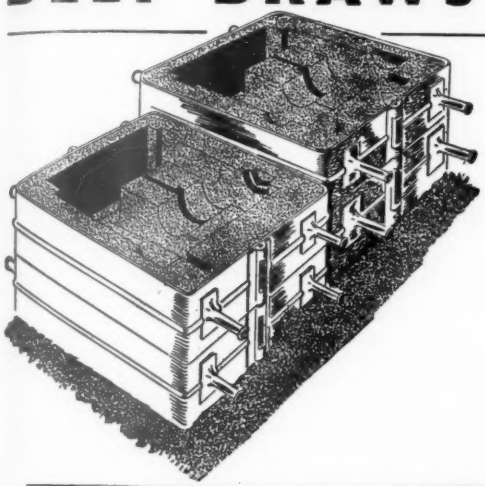
LEAD—*First half August:* August 9, £117 15s. to £118 5s.; August 10, £117 15s. to £118 5s.; August 13, £118 to £118 5s.; August 14, £116 15s. to £117; August 15, £116 5s. to £116 10s.

First half November: August 9, £115 15s. to £116; August 10, £115 10s. to £115 15s.; August 13, £115 15s. to £116; August 14, £114 10s. to £114 15s.; August 15, £114 10s. to £115.

ZINC—*First half August:* August 9, £97 15s. to £98; August 10, £97 10s. to £98; August 13, £97 10s. to £97 15s.; August 14, £95 5s. to £95 10s.; August 15, £95 10s. to £95 15s.

First half November: August 9, £95 15s. to £96; August 10, £95 5s. to £95 10s.; August 13, £95 to £95 5s.; August 14, £93 10s. to £94; August 15, £94 to £94 5s.

DEEP DRAWS...



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Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered unless otherwise stated)

August 15, 1956

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £17 11s. 0d.; Birmingham, £17 3s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £20 8s. 0d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £20 12s. 3d.

Scotch Iron.—No. 3 foundry, £21 14s. 6d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £23 16s. 6d.; South Zone, £23 19s. 0d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £25 4s. 0d.; South Zone, £25 6s. 6d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent. :—N.-E. of England (local iron), £21 7s. 6d.; Scotland (Scotch iron), Zone S. 1, £21 14s. 0d.; Sheffield, £22 14s. 6d.; Birmingham, £23 2s. 0d.; Wales (Welsh iron), £21 7s. 6d.

Basic Pig-iron.—£18 3s. 0d. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered)

Ferro-silicon (6-ton lots and over).—45 per cent. Si, £48 0s. 0d. to £50 5s. 0d., scale 16s. 0d. to 17s. 6d. per unit; 75 per cent. Si, £70 0s. 0d. to £73 2s. 6d., scale 16s. 0d. to 17s. 6d. per unit.

Ferro-vanadium.—50/60 per cent., 27s. 6d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 11s. 6d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £250 0s. 0d.; 38/40 per cent., £299 0s. 0d.

Ferro-tungsten.—80/85 per cent., 17s. 2d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 20s. 2d. per lb. of W.

Ferro-chrome (6-10 ton lots).—4/6 per cent.C, £93 10s.0d. to £95 0s. 0d., basis 60 per cent. Cr, scale 29s. 9d. to 32s. 0d. per unit; over 6 per cent. C, £92 10s. 0d. to £93 0s. 0d., basis 60 per cent. Cr, scale 29s. 9d. to 32s. 0d. per unit; 2 per cent. C,* 2s. 1d. per lb. Cr; 1 per cent. C,* 2s. 1½d. per lb. Cr; 0.15 per cent. C,* 2s. 2½d. per lb. Cr; 0.10 per cent. C,* 2s. 2¾d. per lb. Cr; 0.06 per cent. C,* 2s. 3d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 7s. 0d. to 7s. 6d. per lb.

Metallic Manganese.—93/95 per cent., carbon-free, £249 0s. 0d.; 96/98 per cent., £259 0s. 0d. to £265 0s. 0d.

Ferro-columbium.—65/75 per cent., Nb + Ta, 22s. 6d. to 23s. 6d. per lb., Nb + Ta.

Ferro-manganese (home).—78 per cent., £66 0s. 0d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £28 19s. 0d.; tested, 0.08 to 0.25 per cent. C, £29 19s. 0d.; hard (0.41 to 0.60 per cent. C), £31 0s. 6d.; silico-manganese, £39 10s. 0d.; free-cutting, £33 3s. 0d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £36 14s. 6d., silico-manganese, £39 17s. 6d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £34 13s. 6d.; basic, hard, over 0.41 up to 0.60 per cent., C, £35 16s. 0d.; acid, up to 0.25 per cent. C, £38 17s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £35 7s. 0d.; boiler plates (N.-E. Coast), £37 17s. 0d.; floor plates (N.-E. Coast), £36 16s. 0d.; sectional material, N.-E. Coast, £33 16s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested (4-ton lots), £36 3s. 0d.; flats, 5 in. wide and under (4-ton lots), £36 3s. 0d.; hoop and strip, £36 12s. 6d.; uncoated strip mill coils, hot rolled, under 3mm. to 12g., £38 16s. 0d.; black sheets (hand mill), 17/20 g., £50 4s. 6d.; galvanized corrugated sheets, 24 g., £62 7s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £61 13s. 9d.; nickel-chrome, £85 10s. 6d.; nickel-chrome-molybdenum, £96 16s. 6d.

NON-FERROUS METALS

Copper.—Cash, £304 10s. 0d. to £305 10s. 0d.; three months, £304 0s. 0d. to £305 0s. 0d.; settlement, £318 0s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 3s. 0½d. per lb.; rods, 350s. 3d. per cwt. basis; 20 s.w.g., 383s. 3d. per cwt.

Tin.—Cash, £773 0s. 0d. to £775 0s. 0d.; three months, £770 0s. 0d. to £771 0s. 0d.; settlement, £775 0s. 0d.

Lead (Refined Pig).—First half August, £116 5s. 0d. to £116 10s. 0d.; first half November, £114 10s. 0d. to £115 0s. 0d.

Zinc.—First half August, £95 10s. 0d. to £95 15s. 0d.; first half November, £94 0s. 0d. to £94 5s. 0d.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £129 0s. 0d.; rolled zinc (boiler plates), all English destinations, £126 15s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £110.

Brass Tubes, etc.—Solid-drawn tubes, 2s. 5¾d. per lb.; rods, drawn, 3s. 4¾d.; sheets to 10 w.g., 325s. 0d. per cwt.; wire, 3s. 1¾d.; rolled metal, 310s. 0d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), £197; B6 (85/15), — ; BS249, —.

Brass (High Tensile).—BS1400, HTB1 (30 tons), £265; HTB2 (38 tons), — ; HTB3 (48 tons), — .

Gunmetal.—BS1400, LG2 (85/5/5/5), £274; LG3 (86/7/5/2), £285; G1 (88/10/2/½), £341 ; (88/10/2/1), £325.

Phosphor Bronze.—BS1400, PB1 (AID released), £350 per ton.

Phosphor Bronze Strip, etc.—Strip, 442s. 6d. per cwt.; sheets to 10 w.g., 472s. 0d. per cwt.; wire, 4s. 7½d. per lb.; rods, 3s. 11½d.; tubes, 3s. 9¾d.; chill cast bars: solids 3s. 11d., cored 4s. 0d. (CHARLES CLIFFORD, LIMITED).

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 4s. 2¾d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 7d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 4s. 6d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 4d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £83 15s. 0d. Nickel, £519 0s. 0d. Aluminium ingots, £198 10s. 0d.; aluminium bronze (BS1400), AB1, £300; AB2, — . Solder, brazing, BS1845, type R (50/50), 3s. 1d. per lb., type 9 (54/46), 3s. 4½d. per lb.

* Average 68–70 per cent.

Increases in Capital

RICHARDSON SCALE COMPANY, LIMITED, increased by £19,900, in £1 ordinary shares, beyond the registered capital of £100.

ACORN ANODISING COMPANY, LIMITED, London, N.W.3, increased by £45,000, in £1 shares, beyond the registered capital of £5,000.

WINSOR ENGINEERING COMPANY, LIMITED, Glasgow, increased by £50,000, in £1 shares, beyond the registered capital of £50,000.

BRITON FERRY STEEL COMPANY, LIMITED, increased by £300,000, in £1 ordinary shares, beyond the registered capital of £700,000.

LIGHTALLOYS, LIMITED, London, N.W.10, increased by £50,000, in 5s. ordinary shares, beyond the registered capital of £150,000.

BIRMID INDUSTRIES, LIMITED, Smethwick, 41, increased by £1,000,000, in £1 shares, beyond the registered capital of £3,000,000.

BRITANNIA LEAD COMPANY, LIMITED, London, E.C.4, increased by £300,000, in £1 shares, beyond the registered capital of £100,000.

CLARMAC ENGINEERING COMPANY, LIMITED, Glasgow, increased by £20,000, in £1 ordinary shares, beyond the registered capital of £25,000.

FORDHAM PRESSINGS, LIMITED, Wolverhampton, increased by £100,000, in 1s. ordinary shares, beyond the registered capital of £100,000.

RHEOSTATIC COMPANY, LIMITED, Slough (Bucks), increased by £250,000, in 4s. ordinary shares, beyond the registered capital of £650,000.

KIRK & COMPANY (TUBES), LIMITED, London, S.E.16, increased by £50,000, in 1s. ordinary shares, beyond the registered capital of £50,000.

HUMBER BRASS & COPPER WORKS COMPANY, LIMITED, Hull, increased by £35,000, in £1 shares, beyond the registered capital of £10,000.

ELECTRIC-HYDRAULICS, LIMITED, Warrington (Lancs), increased by £100,000, in £1 ordinary shares, beyond the registered capital of £300,000.

STEEL & METAL PRODUCTS COMPANY, LIMITED, London, E.C.3, increased by £29,000, in £1 ordinary shares, beyond the registered capital of £1,000.

SMART & BROWN (MACHINE TOOLS), LIMITED, London, W.1, increased by £30,000, in £1 ordinary shares, beyond the registered capital of £70,000.

ROCKWELL MACHINE TOOL COMPANY, LIMITED, London, N.W.2, increased by £10,000, in £1 ordinary shares, beyond the registered capital of £40,000.

STEIN ATKINSON VICKERS HYDRAULICS, LIMITED, London, S.W.1, increased by £1,200,000, in £1 ordinary shares, beyond the registered capital of £50,000.

SCINTILLA, LIMITED, electrical and mechanical engineers, etc., of London, N.W.9, increased by £16,500, in £1 shares, beyond the registered capital of £5,000.

BRITISH ALUMINIUM COMPANY, LIMITED, London, S.W.1, increased by £5,000,000, in £1 ordinary shares, beyond the registered capital of £7,000,000.

AUSTIN WALTERS & SON, LIMITED, mechanical engineers, etc., of Manchester, increased by £10,000, in £1 10 per cent. cumulative preference shares, beyond the registered capital of £10,000.

DROP STAMPING COMPANY, LIMITED, Birmingham, increased by £27,500, in 2,500 ordinary and 25,000 5 per cent. cumulative redeemable preference shares of £1 each, beyond the registered capital of £5,000.

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained. Details of tenders with the reference ESB can be obtained from the Board of Trade Export Services Branch, Lacon House, Theobalds Road, London, W.C.1 (telephone: CHAncery 4411, ext. 738 or 771), unless otherwise stated.

INDIA, August 23—Strong doors, for the Director-General of Supplies and Disposals, Government of India. (ESB/18821/56.)

INDIA, September 5—Air compressor sets, for the Director-General of Supplies and Disposals, Government of India. (ESB/19572/56.)

RHODESIA AND NYASALAND, August 23—Heavy duty centre lathe, for the Rhodesia Railways. (ESB/19467/56.)

SOUTH AFRICA, August 24—Primary crusher and conveyor for the Stores Department of the South African Railways. (ESB/19341/56.)

SOUTH AFRICA, September 5—Overhead travelling crane, for the Stores Department of the South African Railways. (ESB/19458/56.)

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39, Corporation Street.
MIDLAND 3375/6.

Liverpool, 2.
13, Rumford Street.
CENTRAL: 1558

Glasgow, C.2.
93, Hope Street.
CENTRAL: 9969.

CLASSIFIED ADVERTISEMENTS

PREPAID RATES: Fifteen words for 7/6 (minimum charge) and 4d. per word thereafter. Box Numbers 2/6 extra (including postage of replies.) Situations Wanted 2d. per word.

Advertisements (accompanied by a remittance) and replies to Box Numbers should be addressed to the Advertisement Manager, Foundry Trade Journal, John Adam House, 17/19, John Adam Street, Adelphi, London, W.C.2. If received by first post Monday advertisements can normally be accommodated in the following Thursday's issue.

SITUATIONS WANTED

FOUNDRY WORKS MANAGER requires change. Conversant with mechanised plant, floor moulding, shell moulding, core-blowing, quoting and sales. Grey iron.—Box FW237, FOUNDRY TRADE JOURNAL.

EXPERIENCED GREY IRON FOUNDRY MANAGER (48), desires appointment. Free to join immediately. Accustomed to full control. Experienced modern fully mechanised plants, employing modern production methods, of light, and medium to heavy castings up to 10 tons.—Box EG230, FOUNDRY TRADE JOURNAL.

REPRESENTATIVE.—A young foundry executive, with vast industrial experience and high technical qualifications, seeks position as Technical Representative in North of England.—Box RA266, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

METALLURGIST required for Australian Steel Foundry situated in N.S.W. Must be fully experienced in the production of carbon and alloy steels by direct arc electric furnaces and able to control physical and chemical Laboratory and carry out research and development. Must also be strict disciplinarian and used to the control of labour. Applicants are invited to apply, stating full details of academic qualifications and experience to date, marital status, and enclosing up-to-date personal photograph.—Box ME267, FOUNDRY TRADE JOURNAL.

AUSTRALIAN Steel Foundry, situated in N.S.W., requires the services of a STEEL SMELTER, with essental previous experience, which should include modern methods of production of carbon and alloy steels by direct arc electric furnaces. Must be strict disciplinarian and used to the control of labour. Applicants are invited to apply, stating full details of qualifications and experience to date and marital status.—Box AS268, FOUNDRY TRADE JOURNAL.

EXPERIENCED FOUNDRYMAN. A position is open for a Technician to carry out sales and service of a high-quality clay-bond extensively used in British foundries. He will be based at the Company's Laboratories in pleasant surroundings. Apply to THE FULLERS' EARTH UNION, LTD., Patteson Court, Redhill, Surrey.

FOUNDRY FOREMAN for Birmingham Works. First-class man, able to organise and get production of brass and gunmetal castings. Experience of core blowing, shell casting, etc., an advantage. Must be thorough demonstrator. Good rates; permanent situation for suitable applicant.—Apply in first instance by letter to Box FF269, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*contd.*

FOUNDRY FOREMAN, experienced executive for Roll Foundry and other castings.—State experience, qualifications, and wages required, Box FF974, FOUNDRY TRADE JOURNAL.

LONG-ESTABLISHED Firm of Die-Casters requires SALESMEN to sell Zinc Base Alloy Pressure Die-Castings, and Aluminium Alloy Gravity Die-Castings, on a straight commission basis. Please state fully details of other lines carried, area at present covered, and commission required. Box LE257, FOUNDRY TRADE JOURNAL.

FETTLING SHOP FOREMEN (2) required by Catton & Co., Ltd., for their steel foundry DRESSING SHOPS. Steel dressing experience desirable but experience in allied fields would be considered. Alternate night shift working essential for one appointment and reference to willingness to work this should be given in replies. Pension scheme and assistance with house purchase if necessary. Replies to CATTON & CO., LTD., Leeds, 10.

FOREMAN required for Whitemetal Die Casting Dept. Must be fully experienced and be strict disciplinarian. House available for suitable applicant. Apply giving details of experience in chrono.ogical order to :—

The Anti-Attrition Metal Co., Ltd., Woodlands Park Works, Maidenhead, Berks.

FOREMAN required for Hand Moulding Section, Non-ferrous Foundry, must be first class Moulder, strict disciplinarian and able to produce high quality castings. House or Flat available for suitable applicant.

Apply giving details of experience in chronological order to :—

The Anti-Attrition Metal Co., Ltd., Woodlands Park Works, Maidenhead, Berks.

IRON MOULDER, NON-FERROUS MOULDER, and IRON MACHINE MOULDER wanted.—MOYLE, Kingston-on-Thames.

CHIEF METALLURGIST, aged between 35 and 45, with a thorough experience of cupola practice and a comprehensive knowledge of core sands for bench and blowing work, is required to take complete technical control in a large Midlands Foundry producing high-duty grey iron castings. An adequate salary will be paid to the successful applicant, and staff pension fund is in operation. The fullest possible details of age, education, experience and positions held should be submitted to Box CM245, FOUNDRY TRADE JOURNAL.

WORKS SUPERINTENDENT required for die-casting works in the Halifax district. Must have considerable experience of labour control, die design, and pressure and gravity die-casting procedure, etc.—Applications in writing, giving fullest possible details, stating present salary, and copies of references, to Box WS262, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*contd.*

ANALYTICAL CHEMIST, male or female, 20-26 years, for new Brownhills foundry. Knowledge of ferrous analysis essential, Sand Testing and control an advantage. Write stating experience, qualifications and salary, etc., to CASTINGS, LTD., Selborne Street, Walsall.

FOUNDRY FOREMAN ASSISTANT, Mechanised Malleable Foundry, South Staffs area. Opportunity for young person with Metallurgical, Pattern Shop and practical experience to qualify for Foundry Management. Apply stating qualifications, salary, etc., to Box FF241, FOUNDRY TRADE JOURNAL.

ELECTRIC FURNACE DESIGN, TECHNICAL ASSISTANT, aged 26-35, required by The Morgan Crucible Co. Ltd. The successful applicant should have experience in the design and operation of electric furnaces with particular reference to electrical control gear. Some high temperature refractories experience would be an advantage. The position, involving frequent visits to customers all over the country to discuss users' problems, is permanent and based on Battersea. There is a contributory pension scheme and a non-contributory life insurance. Please send, in confidence, full personal details to the STAFF MANAGER, Battersea Church Road, S.W.11.

METALLURGIST required for Small Alloy Steel Foundry in Birmingham. Age 23/30. Minimum qualifications H.N.C. or L.T.M. The successful candidate will be responsible to the Group Metallurgist. The work entails routine control and development work in connection with the production of Specialist Castings. Apply, giving full details and salary required, to Box MR265, FOUNDRY TRADE JOURNAL.

SENIOR METALLURGIST required, to supervise new modernised Metallurgical laboratory. The position requires a man capable of dealing with a wide range of problems. The position offers considerable scope in a progressive and expanding organisation. Attractive salary up to £1,000 per annum, plus bonus.—Apply, stating age, education and experience, to the EMPLOYMENT OFFICER, Hoover, Ltd., Perivale, Greenford, Middlesex.

AN ASSISTANT FOUNDRY MANAGER is required by a medium sized South Coast Engineering Company. Applications are invited from men, preferably in their middle thirties, who have had first class experience in modern production management methods in a foundry employing between 100 and 200 men, and producing Ferrous and Non-Ferrous castings up to 10 cwt.

A starting salary of £1,000 per annum will be offered, and a contributory pension scheme is in operation.

Please write, giving fullest possible details of experience and qualifications to BOX AF242, FOUNDRY TRADE JOURNAL.